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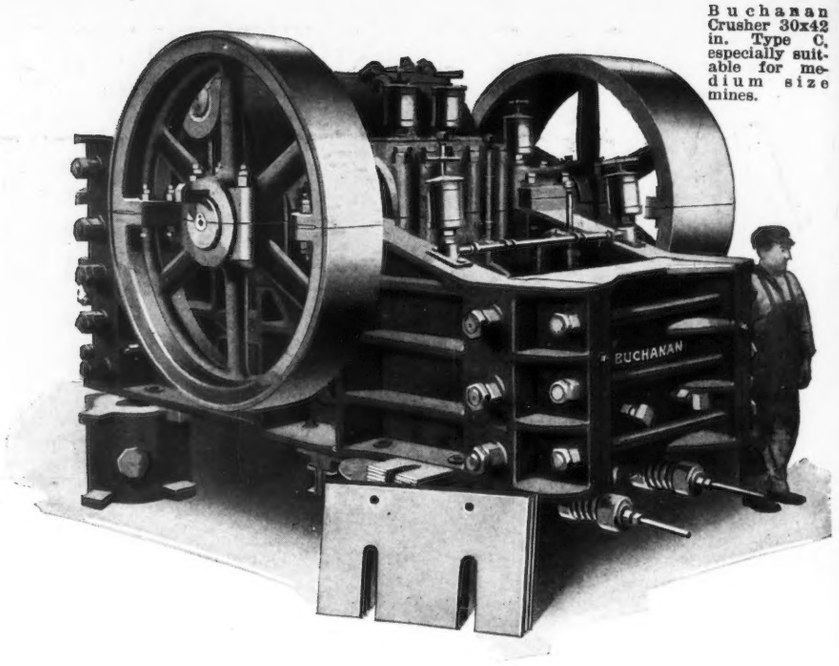

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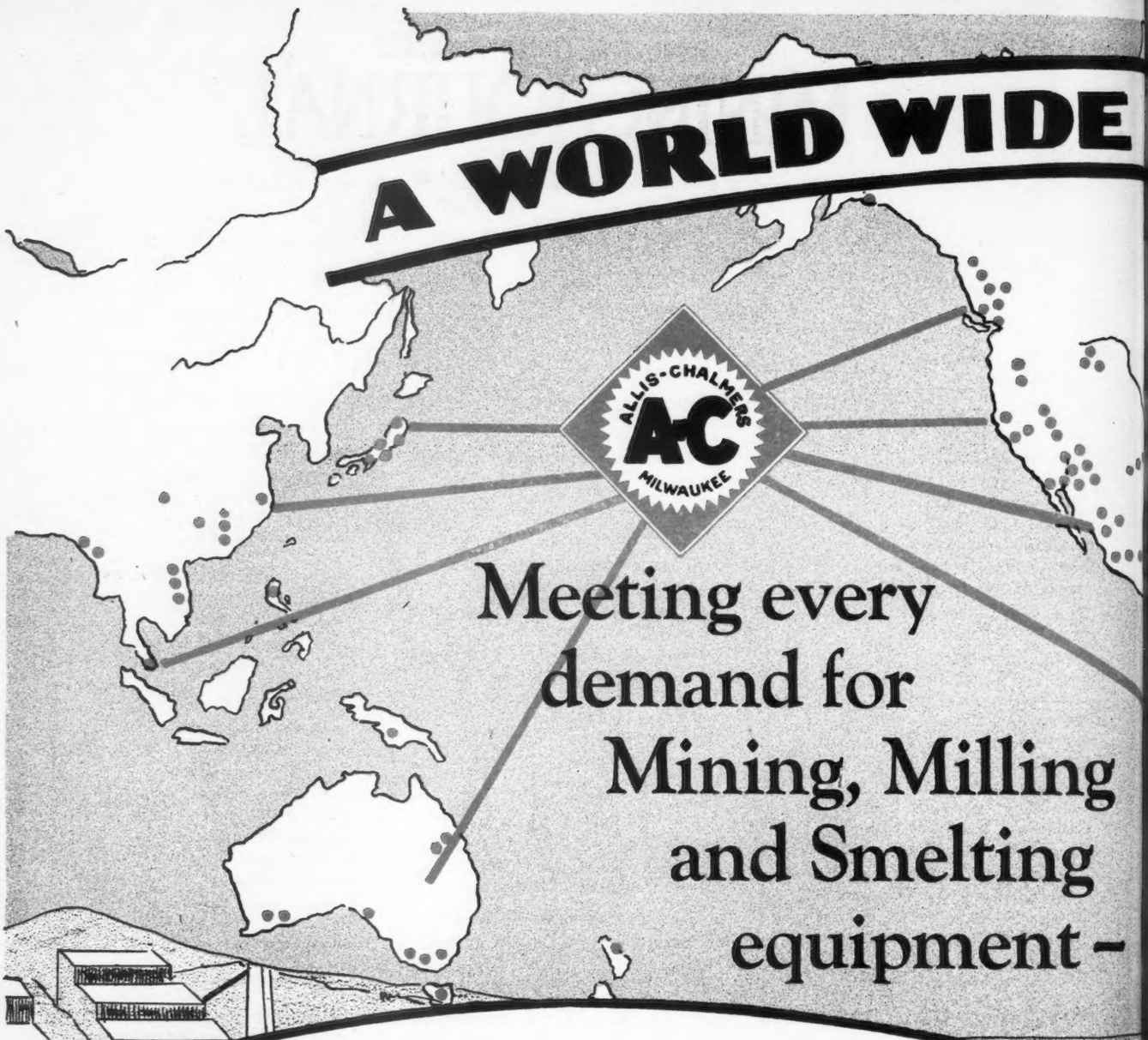
Extra Copies of

E. & M. J. METAL PRICE CHART

A LIMITED NUMBER of reprints of the insert that follows page 96 and that contains the metal price chart, the production chart, and the price table have been made. While they last we will be glad to send copies to subscribers who will write to the editorial department making the request.



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A. W. ALLEN, *Editor*

H. W. CLARKE,
Publishing Director

VOLUME 127

New York, January 19, 1929

NUMBER 3

Progress by CO-OPERATION *Rather Than by* COMPETITION

THE OUTSTANDING EVENT in 1928 of especial significance and gratification to the members of the mining industries of the world was the selection of the Hon. Herbert C. Hoover as the next President of the United States. With abundant hope, with ample justification for that hope, *Engineering and Mining Journal* looks forward to an immediate future of orderly progress and steady advance in the industries it serves and represents, confident that Mr. Hoover's translation to a post of the highest responsibility and the greatest world influence will stimulate confidence and engender mutual respect among the elements of a far-flung group of technologists and engineers.

Progress on an ambitious scale usually results from the application of the experience of many minds. Space forbids even a summary of the technical, engineering, economic, and industrial developments in mining throughout 1928, but the pages following bear witness to the advance that has occurred. Much of this success has been due to group activity and co-operation, in place of isolated effort; to a realization of the mutuality of interest of employer and employee, in place of industrial conflict; to a merging of activities with parallel aims, in place of wasteful competition. As a result, one major industrial tendency is well defined and its logic accepted, auguring for increased service, greater individual satisfaction, and a wider distribution of the wealth that inevitably follows sanely and scientifically directed effort.

The task of *Engineering and Mining Journal*—to act as a clearing house for the achievements of industry and to interpret them to a wider field—is possible only by the co-operation of authorities on the many subjects covered. This is particularly true in regard to the Annual Review Number, of which this is the sixtieth. The editors would pay early tribute to those who are mainly responsible for its success—to our contributors:

Mr. HUNTINGTON ADAMS is a mining engineer who is well known as a result of professional work in Mexico, particularly in regard to the hydrometallurgy of silver; in Bolivia, on tin and international finance; and in Chile on nitrate—the subject on which he writes in this issue. . . . Dr. RAYMOND F. BACON is a chemical engineer with a distinguished academic record and a wide technical experience in the sulphur and pyrite industries. . . . Dr. CLARENCE W. BALKE is recognized as a world-wide authority on tantalum—the subject concerning which he writes. Formerly professor of chemistry at the University of Illinois, he is now director of research of the Fansteel Products Company, North Chicago, Ill. . . . Mr. G. C. BATEMAN, a familiar figure at mining conventions in the United States as well as in Canada, is the secretary of the Ontario Mining Association. He was at one time the manager of La Rose, at Cobalt, Ont., and he contributes the article on the metal which gave that town its name. . . . Mr. H. W. BOYNTON is the specialist on platinum for Handy & Harman, of New York, and closely in touch with world conditions in that subject. . . . Mr. WARREN BRUCE, who writes on diatomite, draws from an extensive research experience on that product in California, where the properties of major economic significance are situated. . . . Mr. H. M. BRUSH, who contributes the article on bismuth, is a vice-president of American Smelting & Refining and the son of Edward Brush, of honored memory, a director of that organization. Mr. Brush is in charge of A.S.&R. metal sales. . . . Mr. CHARLES BUTTERS, who contributes the article on Central America, typifies the versatility characteristic of many mining engineers. On the topic discussed he writes from an intimate and first-hand experience; but perhaps he is best known as a metallurgist and one of the pioneers in the development of the cyanide process, particularly in South Africa and Mexico, and as the inventor of the stationary-leaf vacuum filter that played so important a part in the application of the MacArthur-Forrest invention. . . . Mr. CLINTON H. CRANE is president of the St. Joseph Lead Company and one of the best-known authorities on the subject on which he writes—lead. . . Mr. EDWARD W. BROWN, who contributes the article on salt, is president of the Sterling Salt Company, operating an important property at Halite, N. Y. . . . . Mr. DONALD J. FARQUHARSON is a member of the editorial staff of *The Financial News*, of London, the editor of which is now Mr. W. A. DOMAN, our special correspondent in London and a valued contributor to *Engineering and Mining Journal* for many years. . . . Mr. WILLIAM MONTAGUE FERRY is one of the moving spirits of the American Silver Producers' Association, of which he is president. He therefore writes with an intimate knowledge of economic conditions, bringing operating experience to the problem as a result of his association with the Silver King Coalition Mines, of which he is vice-president and managing director. . . . Asbestos is discussed by Mr. NORMAN R. FISHER, consulting engineer of Montreal, who is in close touch with the conditions prevailing in the asbestos industry. . . . Mr. MARTIN J. GAVIN, of the U. S. Bureau of Mines, is one of the leading technical authorities on oil shale and the author of several monographs on this subject. His article is published by permission of the Director, U. S. Bureau of Mines. . . . Mr. THOMAS W. GIBSON, who contributes the article on nickel, is the Deputy Minister of

Mines of Ontario, with headquarters at Toronto. . . . One immediately associates the name of Mr. H. W. GOULD with modern quicksilver practice, because nearly all the quicksilver produced in the United States comes from furnaces of the Gould type. He is an authority on the economics as well as the metallurgy of quicksilver. . . . Mr. R. J. GRANT, Director of the U. S. Mint at Washington, D. C., was born in Nova Scotia. Adopting mining as a profession, he has practiced in Mexico and Australia, as well as in the United States. As is fitting, he contributes the article on gold. . . . Dr. E. C. HARDER, who writes on bauxite, is an engineer, geologist, and author of wide attainments and extensive experience in the United States and abroad. He is connected with the Aluminum Company of America and directly associated with the Republic Mining & Manufacturing Company . . . . The business of Mr. CHARLES HARDY brings him in intimate contact with the international and national situation in regard to manganese, of which he writes with experience and authority. . . . The aluminum industry is discussed by Mr. S. A. HARTWELL, JR., who is

a member of the sales staff of Aluminum Company of America, and thoroughly familiar with conditions in that field. . . Mr. FRANK L. HESS is chief engineer of the Rare Metals and Non-metals Division of the Economics Branch of the U. S. Bureau of Mines. He contributes the articles on tungsten, radium, and allied metals, which are published by permission of the Director, U. S. Bureau of Mines. . . . Mr. R. E. HORE is a consulting geologist, specializing in the mineral deposits of northern Ontario and acting also as the editor of *Canadian Mining Journal*. He contributes the article on mining in Canada—a subject of which he possesses an intimate and first-hand knowledge. . . . Mr. PREVOST HUBBARD is chemical engineer for the Asphalt Association and the author of several treatises dealing with the subject on which he writes—asphalt . . . . Mr. W. R. INGALLS writes authoritatively of the pyrometallurgy of zinc, on which subject he is a recognized specialist. Formerly editor of *Engineering and Mining Journal*, he is now president of the American Bureau of Metal Statistics and also of the American Institute of Weights and Measures. . . . Mr. G. H. JONES, who contributes the article on fluorspar, is the president of the Hillside Fluor Spar Mines company, operating at Rosiclare, Ill. . . . Mr. F. P. KNIGHT is president of the Mineral Products Company of Beverly Farms, Mass., and is especially well qualified to write on feldspar. . . . Dr. GEORGE F. KUNZ, of Tiffany & Company, is one of the leading gem experts of the world, who claims that he can spot an artificial pearl at the Metropolitan Opera House ten rows away. He contributes the article on precious stones. . . . Mr. OWEN LETCHER is the editor of *Mining and Industrial Magazine of South Africa*, and writes from first-hand knowledge of conditions in the Rhodesias, in the Union of South Africa, and in the Belgian Congo.

Mr. J. VOLNEY LEWIS is a mining and petroleum geologist of distinction and wide experience, and the author of "Determinative Mineralogy." He contributes the article on mining geology, in collaboration with Mr. J. M. WANENMACHER. . . . Mr. K. C. LI, an authority on antimony, was graduated from the Royal School of Mines, London, and has held important executive and engineering positions in China. Among his accomplishments may be included the translation of several highly technical books from English into Chinese. He was at one time commercial attaché at the Chinese Legation at Washington, and is now president of the Wah Chang Trading Corporation. . . . Mr. CHARLES E. LOCKE, who contributes the review on ore dressing, is professor of mining engineering, and ore dressing at Massachusetts Institute of Technology. He was formerly assistant to R. H. Richards, whose treatises are well known to mining engineers. . . . Mr. CHARLES H. MACDOWELL is president of the Armour Fertilizer Works, and a close observer of the international and national status of the potash industry. . . . Mr. L. G. MATTHEWS is assistant sales manager of the American Smelting & Refining Company, and is in close touch with the arsenic situation. . . . Mr. H. C. MEYER, as vice-president of the Foote Mineral Company, of Philadelphia, writes authoritatively on uncommon ores and metals. . . . Dr. B. LEROY MILLER is a geologist, educator, and writer of distinction, and head of the department of geology at Lehigh University. He has an intimate knowledge of the graphite indus-

try and is a regular contributor to the Annual Review Number on this subject. . . . Mica is discussed by Mr. SIDNEY A. MONTAGUE, of the Huse-Liberty Mica Company, Boston, Mass. . . . Mr. H. NISHIHARA contributes the article on Japan and Manchuria, and writes from Dairen, where he is manager for the Andrews & George Company. . . . Mr. ARTHUR NOTMAN is a mining engineer with a broad background of operating and executive experience with the Phelps Dodge Corporation. Since returning to consulting practice he has made a name for himself as an economist and an authority on copper—the subject on which he writes in this issue. . . . Mr. B. F. PHILLIPSON is president of the Climax Molybdenum Company, the largest producer of molybdenum in the world. He writes on this subject with an intimate knowledge of existing and prospective conditions. . . . Mr. J. C. PORTER, a consulting mining engineer of Havana, possesses a first-hand acquaintance with mining developments in the Republic of Cuba. . . . Mr. F. R. RAIFF, who writes on transportation, is vice-president of American Smelting & Refining. . . . The summary on chromite is provided by Prof. EDWARD SAMPSON, of the department of geology, Princeton University, Princeton, N. J. . . . Mr. E. BALIOL SCOTT, who contributes the article on tin, is the editor of *The Mining Journal*, of London—the oldest industry journal in the world. . . . Mr. CHARLES D. SKILLINGS is the editor of *Skillings Mining Review*, published at Duluth, the center of the Lake Superior iron mining region. . . . Mr. E. C. SPEIDEN, as president of Isco-Bantz, of Niagara Falls, is well qualified to write on silica, a product in which his company is vitally interested. . . . Mr. PETER G. TAIT has been a correspondent for *Engineering and Mining Journal* in Australia for ten

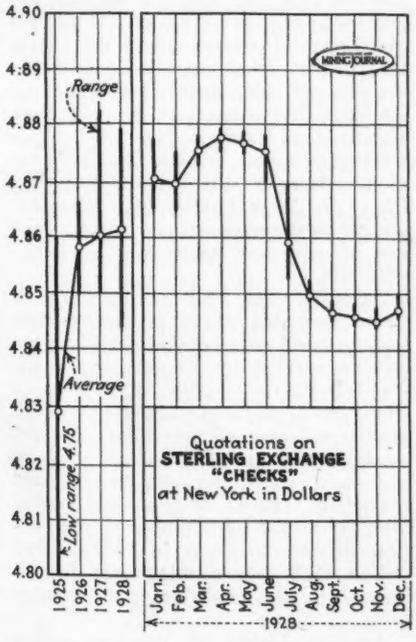
years or more. He is director of the Tait Publishing Company and publisher of *Chemical Engineering and Mining Review*. . . . Mr. S. W. THOMPSON, who writes on barytes, is one of the leading authorities on the subject. He is sales manager of Thompson, Weinman & Company, which operates the Paga mine, in the Cartersville district of Georgia, and other barytes properties. . . . Mr. S. S. TUTHILL is in close touch with developments in the national and international status of zinc. As secretary of the American Zinc Institute, he writes on this subject with an intimate knowledge of economic conditions. . . . Mr. G. D. VAN ARSDALE, a well-known metallurgist, formerly with the Phelps Dodge Corporation and largely responsible for the development of the Inspiration leaching process, contributes the article on hydrometallurgy. . . . Mr. W. L. VAIL is Mexico City correspondent of *Engineering and Mining Journal*. . . . The R. T. VANDERBILT COMPANY specializes in kaolin and china clay and is among the leading factors in that industry. . . . Dr. FRANK A. WILDER, the author of the article on gypsum, was formerly a state geologist. He has contributed extensively to current technical literature and is president of the Southern Gypsum Company, of North Holston, Va. . . . K. D. JACOB, who contributes the summary on phosphate, is research chemist for the U. S. Bureau of Soils, Department of Agriculture, and has been engaged for many years on fertilizer and phosphate-rock investigations. Mr. JACOB was good enough to meet a last-minute request.

Gold

By R. J. Grant

Marked Decline in Future Production a Remote Menace Now

ALTHOUGH prospects favor a marked decline in future gold production, the time when the diminishing supply will become a menace is too remote to occasion uneasiness now. Behind the annual output of new gold lies that great pool of the precious metal which has been built up since prehistoric times. There can be little doubt that gold mined in the days of King Midas still is extant. The amount of gold lost through the centuries probably is much less than would be expected. Recent



revelations as to the thoroughness with which grave robbers worked in ancient days is an indication that even the custom of burying articles of gold with the dead did not withhold the precious metal long from the channels of commercial trade.

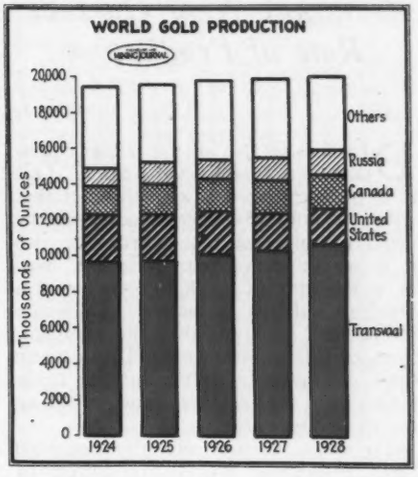
Consumption of gold by the arts is increasing, but there is no reason to belive that the rate of increase will be accelerated greatly. One of the large demands for gold comes from the dentists, but the amount of actual gold used is being reduced through the development of alloys which meet their requirements better. In jewelry and allied applications the amount of gold used is subject to changes in fashion. For example, platinum has come into large use in the jewelry field, and eyeglass trames once made largely of gold are now constructed principally of other materials.

The extent to which gold production will decline in the face of high mining costs and a fixed value for the product is problematic. Even though the peak of production of the Rand may have been passed, it is certain to be a large producer of gold for many years. Engineers and geologists confidently expect the discovery of important new properties in Canada. That country already is producing a large amount of gold at low cost, some of it as low as $8 an ounce. Abundant evidence that the gold-bearing ores of the Cripple Creek camp extend to greater depths is available, but the limit of the economical mining of that area has about been reached. Alaska has been prospected more intelligently than any other mineralized region of the same size in the world, and in many areas the prospecting has been of an extensive character. The fact that no new large gold mines have been developed in that territory has caused general disappointment. As no great amount of overburden is found there, and the rocks are well exposed, the hope once held that Alaska's production might materially increase the country's standing as a gold producer is scarcely justified. Exploration in the Andes has progressed to a point that suggests the probability that South America is deficient in gold supply. On the other hand, prospects are for increased output of byproduct gold from the complex ores.

Despite the small amount of gold coin in general circulation in Continental United States ($3.19 per capita), gold continues to be an important factor in the operations of the mint service, as is indicated by the following statements:

During the last fiscal year the Bureau of the Mint acquired gold to the value of $177,774,995.60. United States gold coin received by the mints for recoinage amounted to $2,216,232.43. Transfers of gold between mint offices totaled $231,983,809.30. The aggregate amount of gold received by the several mint-service institutions during the fiscal year was $411,975,037.33. Mint-service refineries that are operated at New York, Denver, and San Francisco produced during the fiscal year 2,396,394 oz. of electrolytically refined gold. Stock of gold bullion in the mints, assay offices and federal reserve banks on June 30 was valued at $2,780,173,216. Stock of domestic gold coin aggregated $1,328,989,679.

Gold consumed in the industrial arts during the calendar year of 1927 is estimated at $59,318,728, of which $32,857,491 was new material. Export of domestic gold coin increased markedly during the last fiscal year, the total being $218,739,072. During the preceding fiscal year the total was $5,500,953.



Evidently our gold coin circuiates freely in foreign countries.

During the last fiscal year the mints turned out $248,625,000 of double eagles and $970,000 worth of quarter eagles. The mint bureau's laboratory during the year made 3,112 gold assays. The United States coined up to Dec. 31, 1927, $4,166,588,477.50 in gold coins. Of that amount $3,176,877,120 is represented by twenty-dollar gold pieces. The total coinage of ten-dollar gold pieces was $528,119,850 and of five-dollar gold pieces, $391,249,345. Quarter eagles ($2.50) to the extent of $48,171,475 have been coined, in addition to a small lot of commemorative coins. The three-dollar coin, which was popular in the 'fifties, was coined to the extent of $1,619,376. The one-dollar gold piece of the same period was coined extensively, 19,499,337 of them having been minted.

Stocks of gold coin in the United States were estimated on June 30, 1927, as $1,303,369,861. During the last fiscal year an additional $249,595,000 was coined; $500,000 was released from earmark. Imports of United States gold coin during the last fiscal year amounted to $33,836,300. This amount does not include 1,100,000 of gold coins held by the federal reserve banks in trust under earmark for foreign account.

Production of gold in the United States for the calendar year 1927 was $45,418,600. This compares with $48,269,600 in 1926 and with $49,860,200 in 1925. The peak of production was reached in 1915, when the total output was $101,035,700.

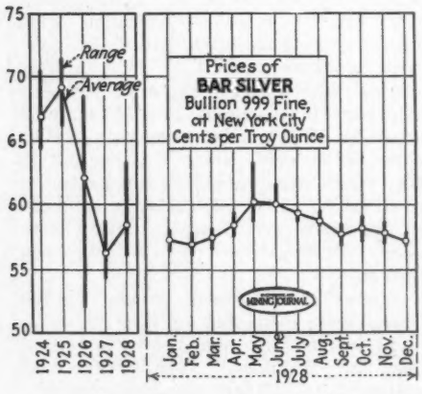
Silver

By W. Montague Ferry

World Output Expected to Continue Near Current Rate of Production

DISCUSSION of the silver question is a complicated matter. One is at once confronted with the fact that silver is not only a commodity in the usual meaning of that word, but also it is an important money metal, used as a medium of exchange by several hundred millions of people. Therefore it becomes apparent that the ramifications of this question extend into many lines of human activity, and its study leads into the cabinets and counting rooms of the world.

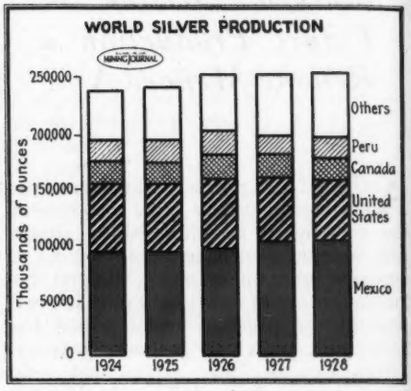
To delve deeply into the recorded facts respecting world production of silver and to determine, analyze, and apply the vital factors concerning supply, demand, and the general price level as affected by gold supply, is work for the economist and the statistician. The limits of this article prevent such extended consideration, and the ability of the writer is hardly equal to the task. Nevertheless, reference must be made to certain established facts and generally accepted theories, in order that a tentative conclusion may be reached as to the probable price level of the white metal in the immediate future.



New silver comes from three sources: Strictly silver ores (dry and siliceous) furnish about 26 per cent; lead ores account for about 28 per cent; copper ores yield about 27 per cent; and the combination of copper-lead, copper-lead-zinc, zinc and lead-zinc ores contribute about 18 per cent, of which substantially all comes from the lead-zinc ores. Silver from dry and siliceous ores is becoming less important, owing, no doubt, to the difficulty of mining profitably at the current price level of the metal and the apparent impoverishment of known deposits. Production of silver from copper ores is decreasing, owing to the lessening of silver content as depth is attained, and because of the fact that the porphyry coppers, which produce the bulk of the red metal, are low in silver. Lead ores are furnishing somewhat less silver proportionately, due also to the fact that silver content grows less as depth is reached. Selective flotation of the various minerals in complex ores, particularly the lead-zinc-silver combinations, is increasing largely the contribution of this class of ores to the world supply of silver. It is probable that this source of supply will continue to furnish an increasingly important amount and proportion to the world production for years to come.

A reasonable conclusion is that the world production of silver will remain not far from its current output of about 250,000,000 oz. per year, with perhaps a slight tendency to increase. Until a few years ago about 60 per cent of the world production was used for money. In spite of the firm establishment of the gold standard, hundreds of millions of people, perhaps half the people on the globe, depended on and demanded silver coin as a medium of exchange. Two events of major importance have occurred that adversely affect the use of silver for money and have reduced the demand for the metal, which in turn tends to lower the market price. During the World War fourteen countries debased their silver coinage, some to the extent of 50 per cent. The market weakened because of this, but became stable at a lower level. India and China, the great consumers of silver, continued to buy, their purchases stimulated, perhaps, by the lower price level. Industrial art used an increasing amount of the metal, and it appeared reasonable to believe that world production would be readily absorbed, and that the price would be stable, with a tendency to advance.

In 1926, like a bolt from the blue, the Indian Currency Commission announced its plan to put India on a gold currency basis and to sell over a period of years 700,000,000 oz. of silver in order to procure the necessary gold. The announcement of this proposal caused consternation among silver miners, who foresaw the probable loss of their best customer, and one that had been absorbing about 30 per cent of the annual world production. Moreover, if this plan eventuated, India would not only not buy, but on the contrary would sell about 70,000,000 oz. per year. Further investigation by representatives of producers, and earnest presentation of persuasive argument to British authorities, resulted in the discovery that these authorities were not entirely sympathetic with the plan as submitted by the Indian Commission. A modification favorable to the silver-producing indus-



try was eventually made. The welfare of the industry itself had little or no weight in affecting this modification; matters affecting world economics and politics appear to have been the governing factors. Confronted with this Indian threat, the silver market again broke sharply, but subsequently regained some strength, and appears to be once more stabilized at a lower price level. This stabilization was brought about by the modification of the Indian Currency Plan, the large buying by China, our present best customer, and an increased use of silver in many of the industrial arts.

Actually, the 1928 consumption of silver exceeded world production, and has absorbed considerable old silver put on the market by France and India. Until India reduces the large stock of silver now on hand, that country will not be a buyer of new silver in substantial amount. China is the most important factor for the present and immediate future. If one could predict accurately that the Chinese would continue to buy as freely in 1929 as they did in 1928, one could go far toward forecasting the probable future market price.

Another important question which remains unanswered is what will be the result of the work of the Kemmerer Commission in China, which seeks to bring about stabilization of Chinese currency and possibly the adoption by that country of the gold standard. Belief that the silver market will strengthen materially during the coming year seems to be unwarranted. On the other hand, nothing is visible on the horizon that warrants the belief that the price for the white metal will be substantially lowered. It seems reasonable to assume that 1929 will show about the same price level as did 1928.

Platinum

By H. W. Boynton

EXCEPT for the early part of the year, the platinum market during 1928 was dull and uninteresting. The price on Jan. 2 was $72 an ounce. From this figure a very rapid advance took place, until $90 an ounce was reached on Jan. 16. Soon afterward, the market started downward, and the price declined steadily to $74 at the close of the year.

The outlook for platinum does not appear to be especially bright. World production is in excess of consumption, a condition which would normally make for lower prices. Russia, the chief producing country, is still playing a lone hand. Platinum is a luxury metal, used principally for jewelry, and in 1927, about 70 per cent of the platinum and iridium consumed in this country was bought by jewelers. Low prices do not stimulate this demand. On the contrary, jewelers claim that consumption would be increased if higher prices prevailed, provided fluctuations were not too wide. Other platinum-consuming industries are not greatly affected by price, as even when the price of the metal is low it is still expensive for commercial use; constant efforts are being made to find suitable substitutes. Cooperation by the various producing countries to restrict production to an amount more closely corresponding to normal demand would be of benefit, and such action may be the only solution to the perplexing problem.

Iridium behaved rather spectacularly during the last few days of 1927 and the early weeks of 1928, rising from about $115 an ounce on Dec. 20, 1927, to nearly $500 an ounce a month later. The market quickly reacted to about $300 in February, and has since fluctuated between $275 and $300. The price of the metal moved downward in 1926 and remained low in 1927 because of unusual Tasmanian supplies. Exhaustion of this excess, coupled with a better demand for jewelry high in iridium content, eventually resulted in a shortage, but, as is usual in such circumstances, the abnormally high price soon reduced demand by bringing on the market supplies that largely corrected the statistical position and resulted in the price falling to about where it was before the 1926 decline started.

Palladium did not join in the upward movement of platinum and iridium, but was freely offered during 1928. The market opened at about $56 an ounce, and declined slowly to $42@$44 at the close of 1928. Relatively high imports of palladium explain in part the weakness in the market. Another reason was the small demand for palladium for jewelry purposes. This demand, which has been lessening for several years, declined still further in 1928, probably as a result of platinum stamping laws which went into effect Jan. 1, 1928, in New York and Illinois, in which states much platinum jewelry is made and sold.

Imports of platinum during the first eight months of 1928, according to the U. S. Department of Commerce, were 82,711 oz., compared with 90,010 oz. for the same period of 1927, a decrease of about 8 per cent. Iridium imports in the first eight months of 1928 were only about half as much as in the same period of 1927, the figures being 1,681 oz. this year, as compared with 3,380 last year. Palladium imports for the first eight months of 1928 were more than three times those for the same period in 1927, the figures this year being 8,067 oz., and those for 1927, 2,654 oz. Statistics on the production of platinum for 1928 are not yet available, but no marked decline is expected.

Metallurgical problems in the treatment of platinum norite ores of the Transvaal are being solved in the laboratory, and, when application of the process evolved is made on a commercial scale, the amount of platinum available from South Africa should be considerable. The problem of marketing will then be even more complex than it is now.

Precious Stones

By George Frederick Kunz

DIAMOND sales by De Beers Consolidated for the year ended June 30, 1928, amounted to £3,311,780, compared with £4,313,674 for the preceding year. Net profit was £2,989,874, and dividends paid totaled £1,345,257. Production in Tanganyika decreased slightly.

In no other industry has such excellent control been manifest as in the diamond industry since 1888. During the war operations were shut down for one year, and through the two-year period of post-war depression operations were curtailed. In 1928 these controlling forces were again employed with satisfactory results to stabilize the industry, which was under pressure from overproduction in the alluvial fields. Following discoveries in the Lichtenberg districts that resulted in an enormous production, diamonds valued at more than £4,000,000 were obtained within six months under government supervision from the alluvial fields near the mouth of the Nolloth River, in Namaqualand; these are being held by the Union government and will be disposed of as the market can absorb them, the proceeds to be used in road building and other public improvements.

Diamond rushes in South Africa have passed into history, and prospecting in the future will be under rigid supervision by the government, so that, even with the finding of great deposits of alluvial stones the market will not recede. Such control of mining will also protect those who have purchased diamonds in the past, as for more than 200 years the diamond has been one of the most portable forms of wealth in every civilized country. Because of the restrictions that have been placed on prospecting and digging alluvial stones, large numbers of unemployed that formerly flocked to the diggings whenever a new discovery was proclaimed are now prevented from competing with legitimate mining operations, and the former constant danger of overproduction is thereby averted. Another feature of 1928 in South Africa was the establishment of a limited diamond-cutting industry at Kimberley.

An innovation in the United States during 1928 was the transportation by airmail of precious stones and jewels between the East and West coasts. The mail plane which crashed in Pennsylvania in October, 1928, carried a large shipment of diamonds, three hundred of which, worth $50,000, were recovered, according to newspaper reports. Several of the larger mines in Africa and elsewhere have for some time been using airplanes for transporting diamonds from the mines. Fine diamonds—that is, stones of absolute purity and freedom from flaws—have never been in greater demand than at present, and exceptional stones have been produced, valued at $50,000, $75,000, and even $100,000 each. Only a small part of the diamonds are being cut in brilliant form; many of the stones are emerald cut, or square, and many of the smaller stones are cut in a form known as baguette, differing from the former table cut stones in that the back is brilliant cut and hence heavier.

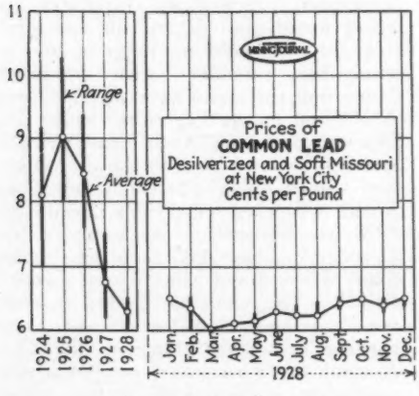
The fine emeralds of Colombia are in much demand, and exceptional stones are selling as high as $2,000 to $5,000 a carat. Many stones with flaws are being sent to India, where a leaf or flower is engraved to cover the flaw, as has been the custom from the time of Tavernier. Exceptional sapphires are being found, and during the last year, near the older ruby workings in Burma, some fine sapphires were produced. Some unusual opals have recently been discovered in the Lightning Ridge and Grawin fields in New South Wales, stones of several hundred carats' weight and valued up to £20,000 having been found. Another remarkable find during 1928 was tourmalines in South Africa, of a darker color than usual but lighter than those found in Minas Geraes, Brazil. The coloring matter is iron not chromium, as in the emerald. According to a long article in the *Gori Journal*, the Russian government is encouraging development of the jasper mines in the Urals. These jasper mines, the most remarkable in the world, have been worked to only a limited extent. A mass of jadeite, weighing 1,317 kg., or more than 2,879 lb., was found at Lake Baikal, Siberia, and is claimed to be of beautiful color. In 1891 the writer found a mass of jade (nephrite) weighing 4,812 lb. at Jordansmühl, Silesia.

Lead

By Clinton H. Crane

Change of Production Trend From Advance to Decline Noteworthy

HIGH PRICES of a commodity encourage production; low prices have the opposite effect. This general principle largely accounts for the behavior of the lead market during the last four years. Eight-cent, nine-cent, or ten-cent lead prices in the years 1924, 1925, and 1926 were a powerful incentive to increase lead production throughout the world. High lead prices not only stimulated the ever-present search for new lead mines, but also accelerated the work of solving troublesome metallurgical problems involving the concentration of complex lead-zinc ores. In 1924 the world lead output was 1,467,000 tons; in 1927 all records were broken by a world production of 1,856,000 tons. But, with a downward turn in the market—lead dropping below 7c. in 1927—production also showed a decrease. In 1928, world lead production is estimated to have been 1,792,000 tons. Although it is true that this is not a pronounced decline from 1927—only 3.4 per cent—the change in the trend of the last four years from an advance to a decline is noteworthy.



The most notable drop in the output of any of the more important lead-producing countries of the world in 1928 took place in Spain and Tunis, owing mainly to the inability of more than a few mines in these countries to make a profit at existing price levels. Other properties preferred to shut down rather than operate at a loss. The United States, Mexico, and Australia also show a moderate diminishing of lead production in 1928.

Here and there in the record of world lead output we find exceptions to the general downward trend of 1928. For example, Canada, Burma, Germany, and Peru show record-breaking lead production in 1928 for their respective countries. Only eight years ago Canada produced lead at the rate of 20,000 tons per year; today the rate is over eight times that much—165,000 tons—and showing an advancing tendency. The vast bulk of Canadian lead production is derived from the complex ore of the Sullivan mine, in British Columbia. This is the most notable individual increase in world lead production of recent years. Practically the entire production is the result of selective flotation.

If Burma continues to increase its lead output at the rate established in 1927 and 1928—74,000 and 88,000 tons, respectively—that country will soon cross the 100,000 tons per year mark and join the select company of the world's six leading lead producing countries: United States, Canada, Mexico, Spain, Germany (including Silesia), and Australia.

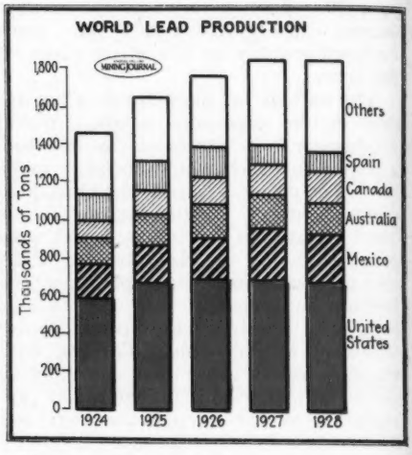
Table I—World Production of Pig Lead

In Short Tons

	1926	1927	1928
United States	696,000	673,000	643,000
Canada	141,000	156,000	165,000
Mexico	221,000	274,000	255,000
North America	1,058,000	1,103,000	1,063,000
Australia	170,000	185,000	174,000
Spain and Tunis	183,000	173,000	104,000
Germany and Silesia	115,000	122,000	153,000
Burma	61,000	74,000	88,000
Others	183,000	199,000	210,000
Totals	1,770,000	1,856,000	1,792,000
Average New York lead price, cents per lb.	8.417	6.755	6.305

Peru is a lead producing country of growing importance. From a negligible output a few years ago, lead production has risen to about 14,500 tons in Peru in 1928, and will probably be double that within another year. The addition of another lead blast furnace to its present unit is being planned by Cerro de Pasco Copper Corporation. This should be in operation by the end of 1929, to take care of the larger output which can be supplied by Peruvian producers.

Selective flotation is the explanation of Peru's present position in the world lead situation, as it is the reason for a great proportion of the increased lead production of the last five years. Last year a detailed note was made of the rôle which selective flotation has played in the world supply of lead. This factor is still extremely important. Metallurgical research never lapses, and



selective flotation continues to offer scope for the ingenuity of technicians. Statistics of the American Bureau of Metal Statistics show the marked improvement in the cleanliness of the zinc-lead separation in various mining centers of the United States and elsewhere in North America. For the Tri-State district the record is shown in Table II.

Production of lead in the United States in 1928 was again lower than in the preceding year, about 643,000 tons, against 673,000 in 1927. Output from Southeastern Missouri mines was at practically the same rate as in 1927, 200,000 tons. Early in 1928, lead production in Utah's lead-mining camps was curtailed, but later increased. Those companies in Utah not blessed with unusually rich silver-lead or lead-zinc ore began to feel the pinch of lower lead prices during 1928. With the labor scale in the lead mines virtually linked to that of the prosperous copper-mining camps, it would be difficult, even if desirable, to make an adjustment of wages.

Sometimes the situation in a declining commodity market is aggravated by the tendency among some producers to speed up production where possible, with the hope that a lower unit margin of profit will be more than compensated by a greater total profit. Of course, if this attitude be adopted by all producers it can become demoralizing, and, in the

Table II—Production of Flotation Concentrates, Tri-State District

In Short Tons

	Lead			Zinc				
	Total	Lead Content	Per Cent	Total	Zinc Content	Per Cent	Lead Content	Per Cent
1924	235,049	96,774	41.17	227,955	109,005	47.82	14,368	6.30
1925	320,513	139,264	43.45	253,989	130,594	51.42	11,064	4.36
1926	392,220	183,047	46.67	404,485	208,834	51.63	16,722	4.13
1927	451,617	220,236	48.77	499,706	265,146	53.06	12,293	2.46

production of a wasting asset, it does not seem to be a commendable procedure.

During 1928, lead producers and consumers took important action in the formation of a Lead Industries Association. Leading lead producers and consumers formed this association because there are problems of industrial and commercial research, substitution, and welfare which are common to all the lead industries, and believing that by fostering the community of interest between producers and consumers considerable benefit to the entire membership might result. Initially, the association is embarking on a statistical program which will furnish information not now available to producers or consumers regarding weekly sales of pig lead, and the production, stocks, and shipments of lead products—information which should help members individually in each lead industry to guide their affairs more intelligently than in the past. Ultimately the association expects to take up other activities specified by its charter.

Minor developments occurred during 1928 in the improvement of lead smelting. One interesting improvement was the use of a mechanical shovel in connection with operation of the Scotch hearths used in two Middle-Western lead smelters. This has resulted in the saving of one of the two men used in the work of tending the furnace.

What of 1929? The outlook for the three chief consuming branches of lead consumption—that is, lead for pigments, cable covering, and storage batteries—is favorable. Lead-covered cable business promises to grow as more and more cable is buried, or current-carrying wires are given protection from storm and other disturbances. As there is every reason to look for an increase in automobile production, storage battery production should continue to have a good outlet. Although white lead and other lead pigments meet intense competition from other materials, they should profit from the continuance of the building boom. Lower lead prices should help meet outside competition. In the last analysis, however, the future is contingent upon what individual adjustment of lead production is made by the various lead-producing countries of the world to consumption, the latter being difficult to foretell.

Sulphur and Pyrites

By Raymond F. Bacon

ESTIMATED shipments of sulphur for 1928 showed a decrease of nearly 100,000 tons. Official figures for production will approximate total shipments, and consequently stocks of sulphur above ground will amount to about what they were a year ago. Prices were steady throughout 1928, no variation in the contract price of $18 per long ton at the mine being reported.

United States Sulphur Statistics

In Tons

	Production	Domestic Shipments	Exports	Total Shipments	Surplus Production
1920	1,255,249	1,040,175	477,450	1,517,625	—262,376
1921	1,879,150	668,672	285,762	954,434	+924,716
1922	1,830,942	857,960	485,664	1,343,624	+487,318
1923	2,035,847	1,146,316	472,525	1,618,841	+417,006
1924	1,220,600	1,055,586	481,814	1,537,400	—316,800
1925	1,409,262	1,228,602	629,401	1,858,003	—448,741
1926	1,890,057	1,495,721	576,966	2,072,687	—182,630
1927	2,111,618	1,282,738	789,371	2,072,109	+ 39,509
1928 (a)	1,975,000	1,300,000	675,000	1,975,000	.....

(a) Estimated.

The domestic market was somewhat slow early in 1928, owing in part to the slow start of the fertilizer industry, which throughout the year was affected by uncertainty in its manufacturing and sales programs. Other industries, however, particularly the acid industry, progressed steadily, so that by the fall of the year the consumption of sulphur had increased substantially. The domestic paper and pulp industry, like that of Canada, had been disturbed, and operated at about 80 per cent capacity. Canada and the United States in 1927 consumed about 1,450,000 tons of sulphur, and figures for 1928 were almost the same. In spite of an unsettled market for paper and pulp, sulphur imports into Canada will amount to between 150,000 and 160,000 tons, or about the same as in 1927.

Exports of sulphur to foreign countries other than Canada have declined nearly 100,000 tons, caused in part by the consumption of stocks accumulated during the preceding year. Industrially,

United States Pyrites Statistics

In Tons

	Production	Imports
1920	310,777	332,606
1921	157,118	216,229
1922	169,043	279,445
1923	181,628	263,695
1924	160,096	243,237
1925	170,081	276,385
1926	166,559	366,151
1927	215,786	250,794
1928 (a)	250,000	400,000

(a) Estimated.

as measured by consumption, foreign countries have been operating about as they did in 1927. Labor troubles were experienced in the Scandinavian pulp districts, but were not serious enough to affect materially the total amount of sulphur used in the export field. Sicily, the second large factor in the sulphur industry of the world, produced and shipped about 250,000 tons, or approximately the same amount as in 1927.

Pyrites competed with sulphur in the United States, as has always been the condition. Activity in the acid industry, together with low imports during 1927, resulted in larger imports throughout 1928. At the end of the first nine months of 1928, statistics of the U. S. Department of Commerce showed that 346,000 tons had been imported, and that this quantity exceeded the total reported for the entire year of 1927, which was 250,000 tons. Estimates indicate that about 400,000 tons was brought into this country during 1928, and, if this is correct, imports were larger than for any other year since 1919. Owing to an improved copper market, an increase in pyrites imports as well as pyrites production was expected.

Various economists prophesy increased industrial activity during 1929. The sulphur industry, under such conditions, may be expected to expand, for, in spite of some slowing up during 1928, the decreased output during 1926 and 1927 was comparatively slight, and demand in those years may be taken as presaging a greater market for sulphur.

Gypsum

By Frank A. Wilder

OUTPUT of gypsum from mines and quarries in the United States in 1928 was about equal to that of the preceding year, being slightly less than 6,000,000 tons. Imports from Canada, the greater part of which originated in Nova Scotia, amounted to nearly 1,000,000 tons. These figures indicate a satisfactory volume of business for the gypsum industry. Prices, however, were not satisfactory at any time during the year, and the value of gypsum products marketed in the United States in 1928 may be 25 per cent below the value of 1927.

Although the combined milling capacity of the industry seems to be considerably in excess of current demands, United States Gypsum, according to reports, is planning to build four additional mills, one in each of the following cities: Boston, Philadelphia, Detroit, and Chicago. During 1928 the mill of Pennsylvania Gypsum, at Chester, Pa., was taken over by Atlantic Gypsum.

The rapidly increasing use of Gyp-Lath was an outstanding feature of 1928. Gypsum board had been used for many years as a substitute for lath and the first coat of plaster. Unless care was taken to see that the second or browning coat was sufficiently thick, cracks often developed around the edges of the board. Gyp-Lath has the same composition as plaster board, but the material is cut in 16x48-in. lengths, and, when nailed to the wall, joints are broken so frequently that plaster cracks are avoided.

Subcommittee 1, of Committee C-11, of the American Society for Testing Materials, co-operating with some of the leading cement companies, carried farther in 1928 its work of testing gypsum-anhydrite mixtures.

Bauxite

By E. C. Harder

A HEALTHY CONDITION prevailed in the bauxite industry in 1928, and the outlook at the end of the year was that this condition would continue into 1929. Consumption in various parts of the world was steady throughout the year, and, although some change from 1927 occurred in the relative position of certain bauxite-producing districts, the total amount produced in 1928 showed only a slight increase over the output of 1927.

World production in 1927 was about 1,620,000 tons, whereas that for 1928 was about 1,680,000 tons. France, as usual, was the largest producer, followed in order of output by the United States, Hungary, Dutch Guiana, British Guiana, Italy, and Yugoslavia. Minor quantities were also produced in British India, Germany, Greece, and Rumania.

Monthly production of bauxite in France during 1928 varied between 40,000 and 50,000 tons, indicating a total production of about 550,000 tons for the year, as compared with 531,468 tons in 1927 and 402,144 tons in 1926.

Bauxite was produced in the United States during 1928 in Arkansas, Alabama, and Georgia, the total output being about 364,940 tons, as compared with 320,940 tons in 1927. Of the 1928 total, about 350,500 tons was produced in Arkansas, as compared with 303,830 in 1927; and about 14,440 tons came from the Georgia-Alabama field, as compared with 17,110 tons in 1927. In Arkansas the main production originated in the Saline County field, but the Pulaski County mines also produced important quantities. Bauxite mines were operated in Georgia in Floyd, Bartow, Wilkinson, and Macon counties; and mining operations in Alabama were conducted in the new Eufaula district, in Henry and Barbour counties, which was opened up in 1927.

Total 1928 United States production was consumed mainly in three industries—59 per cent by the aluminum industry, 19 per cent by the abrasive industry, and 22 per cent by the chemical industry. A small amount was used for refractories.

Imports of bauxite into the United States in 1928 will probably amount to 365,000 tons, divided about as follows: Dutch Guiana, 202,000; British Guiana, 160,000; France and other sources, 3,000. Imports in 1927, as compiled by the Bureau of Foreign and Domestic Commerce, totaled 356,580 tons, as follows: British Guiana, 167,812 tons; Dutch Guiana, 152,807; France, 13,001: Yugoslavia, 7,700; Canada, 7,700; United Kingdom, 7,550; Belgium, 10. Imports from Canada, United Kingdom, and Belgium probably represent transshipments, as no bauxite is produced in these countries. Exports of bauxite and bauxite concentrates in 1928 from the United States will be about 120,000 tons, as compared with 121,858 in 1927. As in the previous year, most of the exports in 1928 went to Canada and Norway.

The bauxite mining industry in Hungary, according to latest reports, experienced little change in 1928. Hungarian mines, in the region southwest of Budapest, were opened up in 1926. According to reports, 240,000 tons of bauxite was shipped in 1927; most of this was exported to Germany for the manufacture of aluminum and chemicals. Present reports indicate that total exports in 1928 amounted to over 200,000 tons, most of which, as in the previous year, was shipped to Germany.

Mining and exportation of bauxite from British Guiana and Dutch Guiana continued uninterruptedly during 1928, a total of about 167,200 tons being exported from British Guiana as compared with 160,872 tons in 1927, and a total of about 204,500 tons being mined in Surinam, as compared with 177,836 tons in 1927.

Bauxite production of Italy in 1928 increased considerably over that of 1927. Present indications are that a total of about 130,000 tons was produced, as compared with 93,794 tons in 1927. Production in Yugoslavia amounted to about 46,000 tons in 1928, as compared with 98,742 tons in 1927, a reduction of more than 50 per cent. Most of it was shipped to Germany for the manufacture of aluminum oxide.

Talc

Editorial Summary

PRODUCTION in the short-fiber talc industry during 1928 was slightly in excess of that for 1927, and the depletion of deposits at a number of mines created interest in the acquisition of new properties. An additional use for talc was evolved by several California producers, who were successful in having it adopted in the face of considerable competition as an ingredient of concrete mixture. Employment of talc as a core wash in casting operations is well established, but its application for killing insect larvæ continues in the experimental stage. An increased demand has developed in the ceramic industry on the West Coast, where talc is being used successfully in the manufacture of tile. Demands from the roofing, paint, and rubber industries remained steady throughout 1928. Imports for the first nine months of the year totaled 20,360 tons, as compared with 18,952 tons for the corresponding period of 1927.

Contracts for 1929 requirements in the eastern part of the country indicate that the tonnage to be produced during the year will exceed the output for 1928. The market, however, is in a serious condition, owing chiefly to the fact that productive capacity greatly exceeds consumption.

Cobalt

By G. C. Bateman

PRODUCTION of cobalt metal and oxides in Ontario during 1928 declined, as compared with 1927. Figures for the first nine months of 1928 show that metallic cobalt and the metal contents of oxides, salts, and unseparated oxides amounted to 460,995 lb., valued at $1,090,130, as compared with 617,940 lb., valued at $1,246,158, for the corresponding period of 1927. This decrease is accounted for by a fire at the Deloro plant that stopped production for more than a month.

The principal source of cobalt in Ontario continues to be high-silver ores and concentrates. On this class of material the shipper is paid for 98 per cent of the silver. Total contents of cobalt metal, if the ore assays over 5 per cent cobalt, is paid for at the rate of 2c. per unit per pound. The smelter charges $20 a ton for treatment and ½c. an ounce for refining the silver. Freight charges are paid by the shipper.

To encourage the mining of low-silver high-cobalt ores, the Deloro company has issued a special tariff for this class of material. This tariff will apply only when the ore carries 8 per cent or more cobalt and when the silver content is less than 500 oz. per ton. On ores containing less than 100 oz. of silver no payment is made for the silver, but the cobalt is paid for at the following rate: Over 8 per cent and less than 9 per cent, $90 per ton of ore; over 9 per cent and less than 10 per cent, $105; over 10 per cent and less than 11 per cent, $120.

An additional payment of $15 per ton of ore is made for each 1 per cent increase in cobalt contents. On ores over 8 per cent cobalt and between 100 and 500 oz. silver, cobalt is paid for at the rate of 3c. per unit per pound, and the shipper is paid for 90 per cent of the silver. This schedule may lead to the development of prospects which have not been operated to any extent on account of the low silver content of the ore.

A satisfactory increase in the market for stellite, a cobalt-chromium-tungsten alloy, prevailed in 1928, and sales were 100 per cent greater than in 1927. Still further increases are expected in 1929. Consumption of cobalt by stellite manufacturers is now greater than that by the ceramic industry, which formerly consumed the greatest amount. Principal cobalt consumers in order of quantity are: Stellite manufacturers; the ceramic industry; and manufacturers of special steel products.

With the assurance of supply that African deposits give, manufacturers have less hesitancy in using cobalt. Nominal quotations for the metal are $2.50 a pound, but lower prices are undoubtedly given on substantial contracts in the steel trade, to encourage greater use of cobalt.

Copper

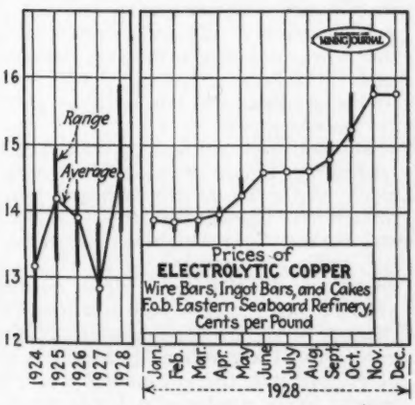
By Arthur Notman

Industry Grows With Steady Increase in Domestic Consumption

EXTRAORDINARY growth in the copper industry was noted in 1928, the result of a resumption of the strongly upward trend in domestic consumption in effect since 1921. This trend reacted with the decline of general domestic business in 1927. A similar trend in Europe had its reaction in 1926.

Under the joint stimulus of activities in both hemispheres, consumption has reached a point where for the time being it is taxing the capacities of the producers to meet the world's need for the metal. The electrical industries, the building trades, and the automobile industry continue to absorb the great bulk of the output. Radio and aviation have added a small but rapidly growing demand. Any slowing down in the three major fields of consumption would be reflected promptly in the activity of the copper industry and its prosperity.

World production for 1928 will show an increase of about 15½ per cent over that of 1927. North and South American output will be about 16½ per cent greater. The following group of twenty North and South American companies owned in the United States has produced between 63 and 65 per cent of the world's output each year since 1923. They are now producing at the rate of about 2,900,000,000 lb. per annum, an increase of nearly 35 per cent over their production in 1927. Exact figures for the calendar year 1928 are not yet available. They will probably show some small increase in their proportion of the total. The twenty companies comprise: Anaconda Copper; Andes Mining; Calumet & Arizona; Calumet & Hecla; Cerro de Pasco; Chile Copper; Copper Range; Granby Consolidated; Greene Cananea; Inspiration; Kennecott; Magma; Mohawk Mining; Miami Copper; New Cornelia; Nevada Consolidated; Old Dominion; Phelps Dodge; United Verde Copper and United Verde Extension.



For the first time in nine months, stocks of refined copper in North and South America showed, on Dec. 1, 1928, an increase over the figures for the previous month, according to the American Bureau of Metal Statistics. The amount of this increase was 6,500 tons. The total was then 52,153 tons, a reduction of 44,323 tons since Jan. 1, 1928. It is too early definitely to forecast a change of trend, but at least a warning bell has sounded, and in spite of the immediate prospect of sustaining consumption at an unprecedented rate, it would seem hazardous to project this rate very far into the future.

Total stocks of blister and refined copper in North and South America, Great Britain, Havre, and Japan, according to the same authority, have fallen to about 35,500 tons since Jan. 1, 1928, and increased about 8,270 tons during November, 30 per cent more than the increase in refined stocks alone. The ability of the industry to respond to such demands is convincing proof of its sound and intelligent organization. Use has been found, for the present at least, for the tremendous expansion of capacities stimulated by the war. That expansion, coupled with misapprehension on the part of the producers of the fundamental facts of the industry, had kept it unduly depressed ever since the armistice until the second half of 1928. The lessons from adversity are usually bitter, but generally wholesome. Enlightened self-interest has apparently taken hold of the situation, to the benefit of producers, consumers, employees, stockholders, and the general public. It is well to remember, however, the homely fable of the dog with the bone in his mouth, who, on seeing his image reflected in the water of the pond, opened wide his jaws to grasp the image of the bone he already had, and, in doing so, lost both the substance and the shadow.

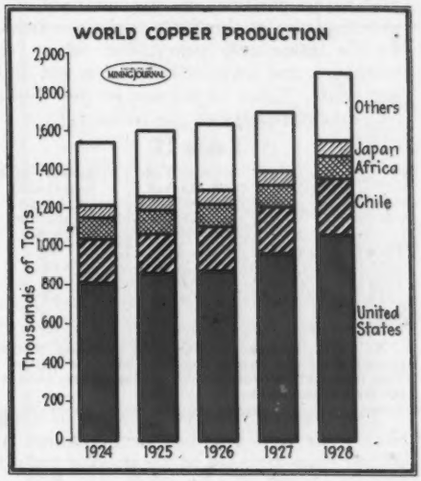


Table I illustrates some of the essential factors in the industry as they have appeared in recent years. The figures are those for the companies listed above, and have been corrected so far as possible for any duplications due to ownership of stock in one or more companies in the group by some other unit of the group.

The figure of 4.44c., per pound produced, being paid out in bond interest and invidends should be compared with 3.65c. to 3.75c. per pound which history shows to have been the average return to creditors and owners of the domestic industry over its whole 90-year life. This return has averaged about 25 per cent of the selling price of the metal. In no five-year period has this ratio fallen under 20 per cent or risen over 30 per cent. It should be noted here that changes in the purchasing power of the dollar affect these comparisons. Measured in 1913 purchasing power, our 4.44c. per pound shrinks to 2.9c. per pound, and the selling price of 16½c. per pound, to 10¾c.

In the five years ended Jan. 1, 1916, a similar group of North and South American companies, which produced about 65 per cent of the world's total for

Table I—North and South American Copper Companies Producing 64 Per Cent of World Total

Year	Market Value Closing Quotations Dec. 31, 1928 (000 omitted)	Production, Pounds (000 omitted)	Bond Interest and Dividends Paid (000 omitted)	Bond Interest and Dividends Paid Cents per Pound	Percentage of Average Selling Price per Pound Paid Out
1924	$1,159,600	1,923,200	$49,000	2.55	19.6
1925	1,142,000	2,029,900	64,090	3.18	22.6
1926	1,140,500	2,112,500	75,040	3.55	25.7
1927	1,435,500	2,142,400	82,560	3.85	29.8
Current rate, estimated	$2,260,000	2,890,000	127,290	4.44	27.3

Note—The market values are based on closing quotations for each year on all outstanding securities of the group. The market value for the current rate was taken at the closing prices of Dec. 28, 1928.

those years, returned 3.76c. per pound of output, with an average selling price of 15½c. per pound. On the basis of purchasing power, it is apparent that the owners of the industry are entitled to a still larger return per unit of production than they are now receiving.

Referring to Table I again, the market value of this section of the industry has nearly doubled since Dec. 31, 1926, and three-quarters of this increase has taken place in the last twelve months. In the same two years, the return to creditors and owners has increased 160 per cent. Table II throws further light on certain aspects of the industry.

Table II

	Average Yield on Market Values as in Table I, Per Cent	Market Value per Pound of Annual Production, Cents
1924	4.2	60
1925	5.6	58
1926	6.6	54
1927	5.6	67
Current rate	5.6	78

Note—In figuring the yield, one company whose stock is not listed on any exchange, has been omitted. This company produced or is producing less than 4 per cent of the total.

The present yield is the same as that of a year ago and has accompanied a 57 per cent increase in the market value.

Such figures as are available point to the conclusion that the trend of costs is still down. It seems probable that current distributions in bond interest and dividends do not exceed 70 per cent of earnings after deducting all charges excepting depletion. The current position of the industry is undoubtedly stronger than it has ever been, and there will be further increases in dividends during the coming year, providing world activity suffers no substantial decline and overproduction is avoided.

News of development in Canada and Africa continues to give assurance that in the years to come these areas stand ready to bear an increasing share of the burden of filling the world's growing requirements for copper.

Diatomite

By Warren C. Bruce

INDICATIONS are that production of diatomite during 1928 was greater than in 1926 or 1927. Its principal industrial uses are still as follows: For heat insulation purposes, as a filter aid, to increase the workability of concrete, and as a mineral filler. About 90 per cent is consumed for the first three uses. Diatomite is also employed for many other purposes, but, common opinion to the contrary, none of these is important to producers, as the tonnage involved is small. No new significant applications were developed in 1928, despite extensive research by producers.

The trend in industry is toward the employment of high temperatures in steam power plants as well as in industrial furnaces. Diatomite is the most efficient heat insulator known for temperatures within the ranges employed, and it forms the major part of most so-called asbestos heat-insulation products. It has no fibrous structure, and, consequently, asbestos is often mixed with it to give fiber strength to heat-insulating blocks, sheets, and pipe covering.

During 1928 the largest manufacturer of asbestos heat-insulation products in the United States acquired control of the firm supplying 85 per cent of the domestic supply of diatomite. This was the outstanding development of the year.

Prospects for 1929 are for an increased use of diatomite in heat-insulation products and filter aids, and for the development of new applications. No increase in consumption for use with concrete or as a mineral filler is expected.

Arsenic

By L. G. Matthews

STOCKS of refined arsenic in the United States in the hands of principal producers on Jan. 1, 1928, totaled about 2,500 tons, and estimated stocks on Jan. 1, 1929, showed little change from this figure. Thus, with domestic production for 1928 totaling about 9,000 tons and imports for the same period amounting to about 11,500 tons, indications are that total consumption of arsenic during 1928 was between 20,000 and 21,000 tons, as compared with 22,528 tons in 1927, and 18,640 tons in 1926. Assumption has been made in the foregoing that all deliveries of arsenic went into consumption, which may not necessarily be the fact, but, as no statistics are compiled showing the stocks of arsenic in the hands of consumers and distributors, the figures represent a close approximation of consumption.

A picture of the arsenic situation during 1928 is presented in the following table:

	U. S. Production Refined (a), Tons	Imports (b), Tons	Total Arsenic Available, Tons	Price per Pound (c) Cents
Jan.	827	630	1,457	4.0
Feb.	668	558	1,226	4.0
Mar.	688	813	1,501	4.0
Apr.	669	1,418	2,087	4.0
May	713	1,413	2,126	4.0
June	732	1,172	1,904	4.0
July	728	1,219	1,947	3.94
Aug.	803	351	1,154	4.0
Sept.	799	785	1,584	4.0
Oct.	835	1,392	2,227	4.0
Nov.	770 (d)	875 (d)	1,645	4.0
Dec.	770 (d)	875 (d)	1,645	....
	9,002	11,501	20,503	

(a) American Bureau of Metal Statistics.
(b) U. S. Department of Commerce Reports.
(c) *Engineering and Mining Journal.*
(d) Estimated.

Two important factors contributed toward a general betterment of the arsenic situation during 1928: First, a stable price level of 4 cents per pound that was maintained throughout the year, and, second, a production confined solely to byproduct arsenic. With the installation of Cottrell and baghouse systems incident to the improvements made in smelting practice, a supply of arsenic from byproduct sources is assured at all times sufficient to meet any reasonable consumptive demand. Inasmuch as the price of 4 cents per pound includes freight from refinery to buyers' works, which averages about ½ cent per pound, and also includes the cost of barreling, which is at least another ½ cent per pound, no claim can be made that the price is excessive. This price level is made possible only by the fact that the arsenic is produced as a byproduct; otherwise the selling price would be considerably higher.

Imports of 11,500 tons during 1928 are about 1,000 tons less than those for 1927. The principal countries from which these imports were received, in the order of their importance, are Mexico, Canada, Japan and Germany.

Manufacturers of insecticides have for years held first place as the principal consumers of arsenic. For the past several years, however, their demands have not shown any tendency to increase. The glass industry, the second largest consumer, has registered a comparatively steady demand for arsenic from year to year. Plant extensions contemplated in the industry, however, may result in an increased demand from this group of consumers. Use of arsenic for weed killer, and its more recent use as a wood preservative, are two outlets for arsenic that give promise of considerable development.

Silica

By Eben C. Speiden

LACK of progress which characterized the silica industry during 1928 was due to lack of recognition of a common purpose on the part of producers and consumers. Quality standards are vital in the successful production and use of any commodity, and such standards in the silica industry are being brushed aside in a keen scramble for low costs by the producer and low purchase price by the consumer.

Statistics as to tons produced are misleading unless they indicate accurately the trend of the industry. Although the tonnage of silica produced is doubtless slightly higher for 1928 than for 1927, the industry as a whole is merely marking time. Prices, on the average, are lower, and qualities, if changed at all, are not improved. High-grade silicas are as readily available as heretofore, but the consuming trend is toward lower gradings at lower prices, with producers quick to sense the consuming demand and meet it by supplying the quality desired.

Reliable indications prevail that the situation described is transitory; that many consumers are again realizing the importance of a quality standard; and that the outlook for 1929 is toward closer attention to factors other than price, with consequent greater satisfaction to both producer and consumer.

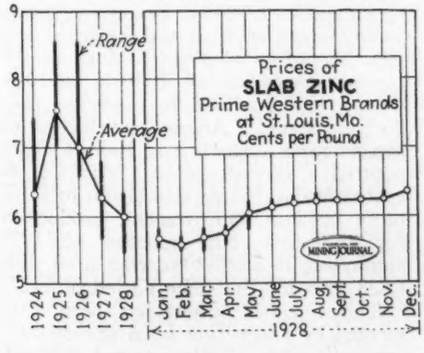
Zinc

By Stephen S. Tuthill

Foreign and Domestic Production Increases—Stocks Unchanged

ZINC production in 1928, both at home and abroad, exceeded that of 1927. World output of slab zinc totaled about 1,530,000 tons, which represents an increase of between 4 and 5 per cent as compared with the preceding year. Domestic slab production, although it exceeded by a small margin the 614,000 tons recorded for 1927, was slightly less than 42 per cent of the world production, which percentage represented the 1927 domestic output. Stocks of domestic slab zinc at the end of 1928 were about 40,000 tons, or the same as at the close of 1927. With monthly shipments of domestic metal averaging more than 50,000 tons throughout the year, stocks were not a menace, especially as they were well controlled and subject to the hand-to-mouth buying prevailing among consumers of zinc. End of the year stocks outside the United States did not exceed 30,000 tons.

Increased domestic metal output in 1928 resulted in the production of more concentrates and a decrease in concentrate stocks, particularly in the Joplin-Miami district during the last few months of the year, when sales of slab

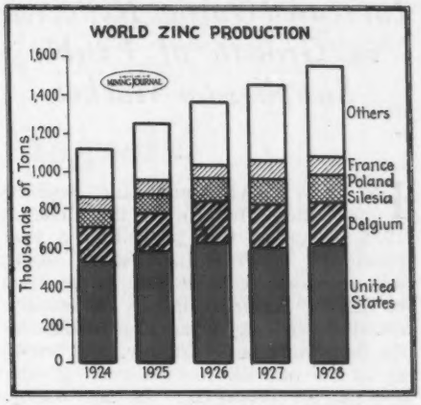


zinc "current" and "futures" expanded markedly. Prices of both zinc ore and concentrates during the last quarter of 1928 were in advance of those for the same period of the preceding year.

Practically no zinc concentrates were exported from the United States during 1928. Exports from this continent originated in either Mexico or Canada the former country shipping the larger quantity. Owing largely to a difference in the Prime Western price here and abroad, 1928 exports of slab zinc did not exceed 35,000 tons; this figure represents a decrease of about 25 per cent, compared with the preceding year. Exports were confined to electrolytic zinc and metal made from foreign ores entering this country under bond. The most promising conditions for an increase in the production of zinc concentrates, as well as metal, prevail in Canada.

Producers of zinc dealt more directly with consumers, avoiding to a large extent transactions with intermediaries and speculators. This practice is growing in the zinc industry, and, if signs are read aright, the tendency in this direction is sponsored by the European zinc cartel, the existence of which has been extended until July 1, 1929. In the mining branch of the industry considerable improvement continued to be made during 1928 in accident prevention and in ore-dressing methods.

Production of electrolytic zinc increased owing to plant additions in Montana and the erection of a new plant in Idaho, which began casting operations in November. Another plant is to be built in East St. Louis, Ill. Concurrent with this increase in electrolytic zinc, domestic supply sources of concentrates and slab metal continued to shift. The number of electrolytic zinc plants in Europe increased from three to six, and the erection of two more, which would bring the potential electrolytic output of Europe to about 90,000 tons a year, is under consideration. Expansion of electrolytic plants in Canada, Australia, and Africa were either begun or planned in the year just closed. With all these plant additions and those proposed in operation, world electrolytic slab zinc production will exceed 20 per cent of the slab output of all grades. Retort plants at Donora and Fort Smith installed sintering equipment so as to handle economically flotation concentrates from the Joplin-Miami district. Several other retort plants in the Middle West operated with increased efficiency as a result of improvements made in operating equipment. So-called new processes for converting zinc concentrates to metal appear, as yet, to be commercially impracticable. High-grade zinc is gradually supplanting Brass Special zinc, and, in the alloy field, use of zinc-base die castings has increased, especially in the automotive industry. Any domestic increase in zinc coating or galvanizing occurred in job galvanizing, and, except in the item of wire, exports of zinc-coated products



declined in 1928. Zinc oxide production, in spite of sharp competition, showed no inclination to decrease during 1928, and lithopone grew in favor as its merits became better recognized. The sheet and strip branch of the industry, owing to increased demands of the automobile and weather-strip industries, was not materially affected by the advent of the house-current radio set, which reduced markedly the demand for radio batteries.

Early in 1928 the national organization of the industry—namely, the American Zinc Institute — published "Zinc and Its Corrosion Resistance," a much-needed and appreciated contribution to the literature of zinc. The same organization, after careful research in the United States and abroad, also published "Zinc Workers' Manual," with a view of interesting sheet metal workers of this country in a wider use of zinc for roofs, gutters, and other building purposes.

Indications are that trends of 1929 in the zinc industry will practically follow those of 1928. Extended personal study of the question of industry's life and growth, however, leads to the conclusion that success or failure of many units of organized industry is being determined by the extent to which responsible officials adopt those co-operative methods that have resulted in improvement in numerous other such divisions.

Slab Zinc Production in United States During 1928

In tons of 2,000 lb.

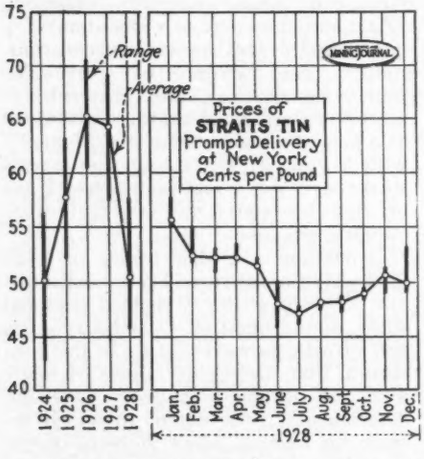
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Illinois	26,945	26,389	25,184	24,730	103,248
Kansas-Arkansas	13,763	13,629	13,369	13,811	54,572
Oklahoma	32,085	28,517	24,977	23,472	109,051
Electrolytic	35,311	41,202	42,410	41,244	160,167
Other States	50,233	48,003	46,468	47,853	192,557
Totals	158,337	157,740	152,408	151,110	619,595

Tin

By E. Baliol Scott

Increased Output Reflected in Growth of Visible Supplies on Market

IN SEVERAL important respects the outlook for tin at the close of 1928 resembled that prevailing a year previous. A great increase in output was recorded—considerably larger than in 1927. Again, difficulty is experienced in tracing what has become of the big increase in supply, and views as to the outlook for the coming year are sharply divergent. In one important respect, however, a difference exists. The visible supply has at length begun to reflect the steady increase in production. Early in December, 1928, it amounted to 21,551 tons, compared with 15,610 tons on Dec. 1, 1927—an increase of 5,941 tons. This increase is far below what might have been expected, considering the augmentation in production and what might be anticipated from knowledge of trade conditions throughout the world during 1928. But whether or not it fairly indicates the postion, no doubt can be felt as to the existence of a comfortable stock



somewhere between what is considered the irreducable minimum of 12,000 tons and the record figure at the end of December, 1922, when after the dislocation caused by the war, visible stocks stood at 22,281 tons, in addition to 17,600 tons in the Bandoeng pool. The importance of this change lies in the fact that no danger exists of consumers finding themselves stampeded into a competitive buying movement in order to secure a supply of an indispensable metal for future requirements. If there is buying of unwanted metal today, it is not by consumers but by speculators.

It is common knowledge that 1928 fulfilled expectations as regards magnitude of output. My revised figures for 1927 gave a net increase of 13,445 tons. This, however, was surpassed in 1928. Although complete data are not available at this time, the monthly returns from the leading fields of the world for ten months show a net increase of 15,332 tons, details of which appear in the accompanying table:

Production of Tin, First Ten Months, 1927-28

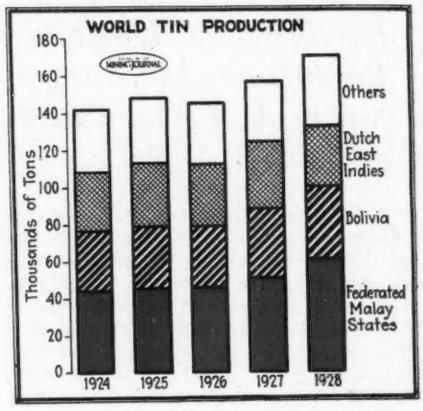
In Long Tons

	1928	1927	Change
Federated Malay States..	51,166	42,557	+8,609
Bancka.....	11,276	12,999	—1,723
Dut h ores to straits.....	16,724	15,999	+ 725
Siamese, Indian and African ores to Straits.....	9,371	8,781	+ 590
Nigeria.....	7,220	6,466	+ 754
Bolivia.....	33,490	27,113	+6,377

The figures in the table, in terms of metallic tin, reveal a net increase of 15,332 tons for the ten months. If the two last months of 1928 be averaged, the total increase for the whole year approaches 18,400 tons. Banka alone, of all main sources of supply, shows a decrease. Other Dutch ores, mainly the product of the Billiton company, show an advance. As Banka probably possesses larger developed reserves than any other great producer, the reduction in shipments of Banka tin is evidently not due to deficiency of supply. Costs were only about one-quarter of the realized price in 1927-28, which indicates that lower prices during 1928 have not proved a curtailing factor. Banka, which is not a private company under the necessity of distributing profits, has preferred in recent years to increase sales when prices were high and to restrict sales on a falling market. Moreover, an increase probably occurred in the supply of Banka ores sent to the Straits for smelting there, but no figures regarding this are likely to be available for another year or so. As will be seen, records by a substantial margin over their previous maximum, in 1927, have been attained by Federated Malay States and by Bolivia, the latter attaining the distinction of stepping into the second place among world tin producers.

The big increase in output from the Federated Malay States may be assumed to be attributable to extended dredge activity, some of it deferred from 1927 owing to delay in completing plants. This is no doubt true to a considerable extent, but one must not forget that dredges contributed only about one-quarter of the total output in 1927. The continued immigration of Chinese labor on a big scale into the Federation, together with the increased adoption of machinery at Chinese-operated mines, was doubtless a factor in the enlargement.

It is too early yet to attempt to estimate what the increase in F.M.S. production is likely to be in 1929. Many new dredges, some of large size, are in various stages of construction. If the price of tin is maintained, a large increase will occur.



In Bolivia the great development of the Patiño Mines and Enterprises Consolidated is the outstanding feature of the year. The report for the nine months recently issued shows a production of 12,438 tons, a gain of slightly over 50 per cent on the same period of 1927, and I understand that the company looks forward in the not very distant future to practically doubling its output, which would mean a production of approximately 24,000 tons per year should such a rate of output be considered desirable.

No sensational increases seem possible in other countries, but, with a continuation of good prices, a steady improvement such as was reported last year should be obtained. Much of the capital subscribed by British interests during 1928 has still to reach the productive stage. Among producers of second rank, Nigeria and Bolivia again secured a record output. The Unfederated Malay States also began to show more marked improvement, production for the first nine months of 1928 amounting to 2,669 tons, compared with 1,828 tons for the same period of 1927.

The Cornish output has been augmented by production from several new properties, but whether or not this will be sufficient to offset the loss of Tresavean, which closed down in April, it is impossible as yet to judge. Portugal production figures are difficult to obtain. Much activity has been witnessed there of late. Output in 1927, according to the best figures I can obtain, appears to have been about 2,000 tons. An increase will doubtless be revealed when the 1928 figures are collected.

Chinese production in 1928 will prob-

ably prove to have been about the same as in the previous year. Exports from Yunnan for the first six months were 3,186 tons, compared with 3,317 tons for the same period of 1927. Increased activity is also reported from Indo-China, where French interests are methodically developing tin-wolfram deposits. More attention is being paid to occurrences of tin in Spain and France, although production from these sources is hardly likely to be important, at any rate for some time.

Arrangements made between the Billiton Maatschappij and the chief British interests operating in the Tanganyika-Uganda tin field in Central Africa are indicative of more serious prospects in this area. No additional production is reported from Australia. Shipments from mines in the Union of South Africa for the first nine months of 1928 contained 869 tons of tin, as compared with 886 tons for the same period of 1927.

Consumption improved appreciably during 1928. United States' deliveries for the twelve months amounted to 78,865 tons, as compared with 72,490 tons in 1927, an increase of 6,375 tons. Hitherto it has been usual to treat these delivery figures as roughly equivalent to consumption; but, owing to the establishment of the National Metal Exchange in New York, it is possible that a nucleus supply has had to be accumulated as a trading basis. Though such reserve will probably be maintained so long as the exchange functions, an allowance between deliveries and actual consumption may be proper. Early in December, 1828, a report was current in London that about 500 tons of November deliveries had gone into private warehouse, possibly to such a destination.

Outside of the United States it is more difficult to speak with certainty. Ricard & Freiwald's trade statistics put world deliveries for the first eleven months of 1928 at 117,108 tons, compared with 109,101 tons for the same period of 1927, a gain of 8,007 tons, but these figures include entries regarded as exceptional and representing tin that has been lifted from the market and not gone into consumption. This amount cannot be known, but the market believes it is considerable. For instance, United Kingdom deliveries during November aggregate 3,286 tons, as compared with 1,371 tons in October and 1,545 tons a year before. The general condition of British trade does not support the idea that any marked increase in consumption occurred in the United Kingdom during 1928. Much the same may be said of Germany, where a period of slackening activity, culminating in the lockout in the iron and steel trade during November, is expected to show reduced activity in the second six months of the year. "Outside" countries, principally the Far East, recorded considerable development in deliveries during 1928, but as some tin from China was shipped from Hongkong during September-October, which had previously figured as delivery, it is difficult to feel confident that all of the increase represents consumption.

Total deliveries for the first eleven months of 1928 comprise: United States, 71,710 tons, against 67,980 tons; Europe, 37,738 tons, against 35,757 tons; outside countries, 7,660 tons, against 5,364 tons in 1927.

Even, however, if allowance be made for the full improvement shown in the foregoing — viz., 8,007 tons for the eleven months as all consumption—it will be apparent that there was a very substantial gain in production over consumption during the year, approximating probably, 10,000 tons.

The outlook for 1929 is difficult to forecast. If the delivery figures are representative of actual consumption, the surplus of production over consumption does not appear quite so large as in 1927. On the other hand, the price of the metal at the beginning of December is above the average for the year—probably a little under £230. Consequently, no check to production can be anticipated unless prices fall substantially. The theory of the interests supporting the market appears to be that as the extra supply is coming from old mines, the impulse must spend itself before long; and, if the market be sustained in the meantime, that increasing consumption will within measurable time overtake the surplus without the necessity of disorganizing production by allowing the price to slump when production is at maximum intensity. Owing, however, to the present difficulty of foreseeing how much further production will expand at current prices before stability in output is reached, many observers fear that the task will involve difficulties too great to be surmounted. All that can be said with certainty is that we are witnessing the development of new forces in the tin market which, as in so many other departments of industry, are working on economic theories that are novel and in conflict with experience of conditions in earlier days.

Feldspar

By Frank P. Knight

DELIVERY of ground feldspar to consumers during 1928 was about 225,000 tons. Total valuation of this tonnage was probably less than that of the output in 1927, which the Bureau of Mines valued at $3,564,141.

Changes in location of producing plants resulted in a decrease of output in Maine and Tennessee and an increase in North Carolina. Competition was keen. Producers realize that the present practice of taking business at cut prices is demoralizing and will result in suspension of operations on the part of some producers. Steps to remedy the situation are being considered, and a better understanding among operators, as well as consolidations, will probably prevail in 1929.

A "buyers' market" continued throughout 1928, and capacity to produce was more than double market requirements. Consumers stocks were low as a result of hand-to-mouth buying, whereas those held by producers were large. Imports of crude feldspar in 1928 amounted to 10 to 12 per cent of the total consumption; practically all of this came from Canada.

Magnesite

Editorial Summary

MAGNESITE produced in Washington goes principally to the refractory trade, which absorbs the dead-burned product. Caustic-calcined magnesite is also produced. Until recently the greater part of the California magnesite produced has been in the form of caustic calcined, application of which as stucco has declined almost to the vanishing point. The flooring business has remained almost stationary. As a consequence producers are entering the refractory field and manufacturing and marketing both dead-burned and fused magnesia products. Experimental work to develop new refractory uses has reached a point where a promising outlet has been secured. Noteworthy in the refractory trade was the cut in price from $29 to $22 per ton for the Chewelah dead-burned product. This cut was apparently made to meet the competition of cheaper substitute refractories made from dolomites.

Magnesite production in California and Washington was about the same in 1928 as in 1927, although in California more magnesite found an outlet as dead burned than ever before. Production in both states is made principally by three producers. California production was 49,093 tons in 1927. The increase in the tariff rate on caustic calcined, made late in 1927, materially helped the producers.

Little technical progress is noted, although attempts to precipitate magnesia from sea water have been made at San Francisco. Residual bitterns and other sources of magnesia, however, are economically more advantageous for such purposes. Magnesium chloride from Michigan is used as a source of magnesium metal.

Imports of crude and caustic-calcined magnesia were less in 1928 than in 1927, the comparative amounts for the first nine months of the two years being 5,053 and 7,774 tons, respectively; dead-burned and grain magnesia imports in 1928 were greater than in 1927, the respective figures being 42,973 and 40,536 tons. A smaller amount of magnesium salts was imported in 1928 than in 1927.

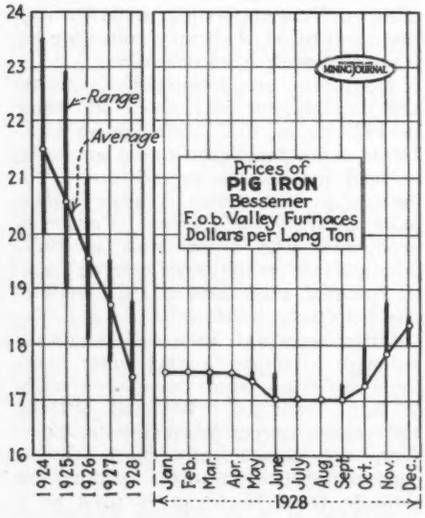
Iron

By Charles D. Skillings

Shipments from Lake Superior District Exceed Those of Preceding Year

LATE in the autumn of 1928, consumers of iron ore who depend upon Lake Superior for their supplies increased their ore demands for an additional total of 2,000,000 gross tons. Original estimates of the Lake movement of iron ore for the navigation season ranged from 51,000,000 to 52,000,000 tons, but the actual shipments totaled 53,980,874 tons. This compares with 51,107,136 tons shipped during 1927.

Iron ore movement during the season just ended was behind that of 1927 every month until October, because of the late opening of navigation. October showed an increase of 613,217 tons over the record for the corresponding period for 1927, and final shipments disclosed a total season increase of 2,873,738 tons. All factors favored the consumers in making their extra demands upon the mines so late in the season. Weather



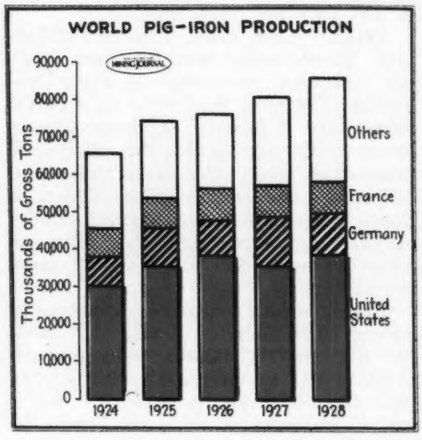
conditions were almost ideal, and an excellent draft of water prevailed in the connecting channels of the Great Lakes. Temperatures continued so mild in November that it was unnecessary to thaw any ore. The result of favorable conditions was that 4,260,942 gross tons of iron ore was forwarded by boat in November, as compared with 2,000,422 tons during the corresponding month of 1927.

Consumers of iron ore increased substantially their schedules of raw material, on account of the vigorous revival of the iron and steel industry last September. They place great reliance on the district's facilities for meeting emergency demands. Those facilities are unsurpassed for handling great tonnages with almost unbelievable dispatch, and necessitate close co-operation on the part of the iron mines, the ore-carrying railroads, the large and modern Lake ships, and the loading and unloading ore docks. All constitute a great machine which operates so smoothly that only those intimately acquainted with its workings comprehend what producing and delivering millions of tons to the dock or furnace yard 1,000 miles distant really involves.

Producers and shippers in the Lake Superior region believe that consumers of iron ore will require about 60,000,000 tons from the mines during the 1929 season. It is too early to forecast that far ahead with accuracy, but the outlook is encouraging for a greater total shipment of ore in 1929 than in 1928. If shipments should total 60,000,000 tons, a peace-time record will be established. The present peace-time record is 59,036,705 tons, which was forwarded in 1923. When the all-rail ore movement for 1928 is compiled it is expected that total shipments from the Lake Superior region will be about 55,000,000 gross tons.

The 1928 season was without special feature, other than that excessive rains during the summer occasionally interrupted or reduced the scale of operations at some of the open-pit mines. Development of a new open-pit iron mine was started on the western Mesabi range by the Nelson Mining Company. It is named the "Greenway," in honor of the late General John C. Greenway, of Ajo, Ariz., who was prominently identified with the Lake Superior mining country prior to his going to Arizona. A washing plant will be built at the mine. Plans are said to be in progress which may result in the resumption of the sintering plant at Babbitt, Minn., on the eastern Mesabi range, either by the Mesabi Iron Company, which owns the properties, or by association or merger of the company with some large consuming interest. The product of this plant comes under the classification of Old Range ores, and it has been impossible to produce it profitably at prices prevailing during the last few years. Mesabi Iron relies upon the open market for the sinter, and the plant, which has a capacity of 800 tons of sinter a day, has been idle since early in 1924. The company has large reserves of low-grade magnetite ores.

The greatest amount of iron ore ever sent by boat from the Lake Superior district in a single season was in 1916, when 64,734,198 gross tons was shipped. Since the war, 50,000,000 tons has been considered an ordinary season. About twenty years ago a prominent steel man declared that the time would come when



the iron and steel industry would demand 50,000,000 tons of ore from Lake Superior mines in a single season. This was regarded as a cheering prospect, but most people then thought that that time was a long way off. The war hastened the arrival of that day, and in six of ten seasons since the war, 1919 to 1928 inclusive, Lake shipments have exceeded 50,000,000 tons, and, moreover, the six include the last four seasons. Students of the iron-ore and steel situation are confident that the time when the steel industry will normally require 60,000,000 tons annually of Lake Superior iron ore is not far in the future.

The iron-mining industry of Minnesota is carrying a heavy burden of taxation, but action expected at the state legislature this winter will if translated into law afford at least some relief. The legislature intended that this tax should be paid by the fee owners of the iron ore, but court action by the latter has placed the burden on the operators. This step has resulted in closing some mines. The present schedule for iron ore is $1.30 per ton below that of four years ago. The only companies operating at a profit are those that have been in a position to effect economies. Exploration work is practically at a standstill because of the heavy taxes which are imposed as soon as a new orebody is found. Research work, to find a simple process for the elimination of sulphur from Michigan ores and to beneficiate low-grade hematite ore, is being continued.

Minnesota iron mines furnished about 38,601,258 gross tons and Michigan and Wisconsin mines about 15,379,616 gross tons of the Lake movement of iron ore in 1928.

Uncommon Ores and Metals

By H. C. Meyer

CONSUMPTION and market prices of the so-called uncommon ores and metals, with the exception of zirconium, sufficient quantities of which were secured with difficulty, showed only slight and unimportant changes during 1928. Ferrocerium, owing to its pyrophoric quality when abraded, was used extensively in the manufacture of pocket lighters, but the quantity consumed for this purpose was comparatively small.

Caesium—Caesium appears on the market in the form of its chloride, nitrate, or hydroxide; only rarely is it used in the metallic form. Pollucite, which is the only true caesium ore, is a caesium aluminum silicate and contains from 15 to 30 per cent of caesium oxide. The only commercial deposits known are in Maine. Caesium is also found in lithia mica, or lepidolite, from certain localities, but seldom is a lepidolite found that carries more than 1 per cent of the element. During 1928 demand declined for caesium compounds, which had been used in comparatively large quantities in the manufacture of radio rectifier tubes. Certain azides and carbonyl compounds of the heavy metals are said to have been used instead for this purpose. The price of pollucite is based on the caesium oxide content and varies from 50c. per unit to $1 per unit, depending on the quantity on the market. No figures are available as to the production of caesium ore during 1928. The outlook for 1929 is for lower prices on caesium salts and probably a further decline in the demand.

Cerium—On the market, cerium appears in a form known as cerium mixed metal, which is really an alloy of cerium metal with metals of the cerium group, such as lanthanum, praseodymium, and neodymium. By alloying this mixed metal with iron, a ferrocerium is formed, which is used in comparatively small quantities in the manufacture of pocket lighters and for other similar purposes. Owing to its pyrophoric nature, it throws off a shower of sparks when filed or abraded. During 1928 the price of ferrocerium, duty paid, was about $5.75 per pound. Cerium metal sells for around $2 per pound less. Prices on material of domestic manufacture ranged from $6 to $8 per pound. No important increase in demand can be expected in 1929 unless some new uses are developed.

Selenium and Tellurium—Selenium is sold in the form of a black powder. No commercial ores of selenium exist, the chief source of the element being the annode muds obtained in the electrolytic refining of copper. Its most important use is in the glass industry as a decolorizer and for producing ruby glass. Vitreous enamels in shades of red and orange are produced by using selenium in conjunction with cadmium sulphide. Selenium is also used in the rubber industry for increasing the wear-resisting qualities of rubber-sheathed electric cables. The price during 1928 was fairly stationary, being around $2 per pound. Tellurium, although available in nearly as large quantities as selenium, has no important commercial uses and no fixed market price for the metal prevails.

Thallium—Thallium is marketed in metallic form in sticks and also in the form of a sulphate and nitrate. The metal has no important uses, but the sulphate is used extensively as a poison, when mixed with certain edible substances, for rats, mice, ground squirrels, and gophers. For such purposes this poison is claimed to be superior to arsenic, phosphorus, or red squill. Metallic thallium resembles lead closely in its physical and chemical properties. Source of supply is mainly from flue dust produced at sulphuric acid plants. The price of the metal during 1928 ranged from about $12 to $15 per pound. The sulphate sold for the same price. As production is limited, a larger consumption during 1929 may be considered probable.

Titanium—Demand for titanium ore and its products continued unabated during 1928. The only two commercial ores of this element are the natural oxide, rutile, and ilmenite, an iron-titanium oxide. Large commercial deposits of rutile are found in Virginia and Florida, and in Norway and Australia. Ilmenite is more widespread in its occurrence, and large deposits of both the massive mineral and the sand are found in various parts of the world. Being more plentiful and considerably cheaper than rutile, ilmenite is the ore generally used in the production f ferrotitanium and titanium oxide. The latter is a white substance, the use of which is rapidly increasing as a substitute for zinc oxide, lithopone, and white lead. Its properties make it superior to all of these older pigments employed in the paint industry. Smaller quantities are used in the manufacture of glass, and lithographic and printing inks, besides in a number of other industries where a white, inert pigment is required. The oxide is marketed in pure form, which averages about 97 to 99 per cent titanium oxide, and also in a blended form containing precipitated barium sulphate. Pure oxide in ton lots during 1928 sold for from 27c. to 31c. per pound. No indication prevails that prices will increase during 1929, but it seems probable that consumption will be larger. Ilmenite sand sold in carload lots for about $17 to $20 per ton for material carrying a minimum of 45 to 50 per cent titanium oxide. Rutile sold in carload lots for about 15c. to 18c. per pound, which is an increase over 1927 prices.

Zirconium — Considerable difficulty was experienced in 1928 in securing sufficient quantities of zirkite, the high-grade natural oxide, mainly owing to the unwillingness of producers to install suitable machinery for sorting or concentrating the ore. An active demand also prevailed for zircon, the silicate, production of which likewise was insufficient to meet the demand. Use of zirconium oxide is steadily increasing in the refractory industry in the manufacture of brick, crucibles, and other products, and also in the preparation of high-temperature cements. Pure oxide is manufactured either from the natural oxide or from zircon. The natural oxide ranged in price in 1928 from $65 to $70 per ton in carload lots for standard 75 per cent zirconium oxide, and from $52 to $56 for 65 to 70 per cent material. Pure oxide ranged in price from 75c. to 90c. per pound. Zircon sand sold in carload lots for $95 per ton. A considerably larger demand is expected in 1929.

Tantalum

By Clarence W. Balke

APPLICATIONS of metallic tantalum which developed and increased in importance during 1928 stand as the best indication of the trend of industrial uses of the metal during 1929. Along some lines a marked increase in the consumption of tantalum has occurred and the number of applications of the metal has increased. The best single outlet has undoubtedly been that in connection with the manufacture of radio and power tubes, and indications are that increasing quantities of tantalum will be consumed in this line of manufacture. The peculiar properties of the metal, and especially its better action, make it extremely important in this industry.

Increasing quantities of tantalum are also being used in the manufacture of certain alloys for specific purposes. Material progress has been made in the adaptation of the metal to the manufacture of spinnerets used in the manufacture of artificial silk, particularly in the viscous process.

Because it is resistant to corrosion, tantalum is beginning to find application for the lining of chemical equipment where unusually severe corrosive problems must be met. On account of the colors which can be produced on it, the metal is also attracting considerable attention in the jewelry field, and it undoubtedly will find a permanent use in certain lines of this industry. The great advances which have recently been made in the fabrication of tantalum will without question open a still wider field for its application.

Graphite

By Benjamin L. Miller

THE graphite industry during 1928 presented no developments of note. As in former years, Ceylon, Madagascar, and Mexico, each furnishing a distinctive product, dominated the situation. Ceylon is practically the only country in the world where lump crystalline graphite occurs in economic quantities; Madagascar possesses the largest deposits of cheaply workable flake graphite; and Mexico supplies the highest-grade amorphous graphite. Many other districts in the world, however, contain extensive deposits of the flake and amorphous varieties, and, under favored conditions, are able to compete with Madagascar and Mexico in the cheaper grades, or in grades for particular purposes. Several other districts, therefore, must be considered in a review of the industry.

As in many other industries, the market for graphite is limited, reserves are extremely large, and competition is consequently keen. Ceylon, which at one time had almost a world monopoly on high-grade graphite, has had its field invaded by the Madagascar product, and these two countries together present serious opposition to the crystalline-graphite producers of other parts of the world.

In Ceylon a slight improvement was noted during the first part of 1928. On Oct. 9, 10,730 tons had been shipped from the island during 1928; of this quantity 4,987 tons came to the United States. The remainder was forwarded to fourteen different countries, but mainly to Germany, the United Kingdom, Japan, and Italy. The corresponding period during 1927 showed an export of 10,453 tons, of which 3,874 tons was shipped to the United States. Ceylon operators are dissatisfied with the situation and have suggested various ways for enlarging the markets and reducing costs so that they can more advantageously compete with Madagascar.

A slight increase in the exports of graphite from Madagascar during 1928 is expected, 8,090 tons having been shipped during the first six months. Prices to operators declined during the year and several smaller companies were forced to close, especially those that were unable to produce an 85 per cent carbon product. France and England took the bulk of the output, but much of that going to the former country was trans-shipped to other countries. The United States, however, receives a large part of its imports direct from the island.

Mexico continued, as heretofore, to supply the market for high-grade amorphous graphite. During the first nine months of 1928, 4,233 tons was shipped to the United States; a portion of this was trans-shipped to other countries. Chosen (Korea) increased its production during 1928. In the first six months, 670 tons of flake graphite and 10,700 tons of amorphous were exported. No new developments in Canada were reported. The Black Donald mine, at Calabogie, continued as the principal producer. New discoveries of graphite were reported in Brazil, about 50 miles from Ceara, and in the northern Osetia district of Russia.

In the United States, crystalline graphite was produced during 1928 in Alabama, Texas, California, New Jersey, and Montana, and amorphous graphite in Michigan, Rhode Island, and Nevada.

Alabama, as in former years, was the largest producer. Companies operating in the state were: Ceylon Graphite, Hollins, Coosa County; Bama Graphite, Mountain Creek, Chilton County; and the Superior Flake Graphite, Ashland, Clay County. The first two companies are now owned by Southwestern Consolidated Graphite. The plant of Alabama Quenelda Graphite, Lineville, Clay County, was overhauled, preparatory to resuming operations.

The new mill of Southwestern Consolidated Graphite at Burnet, Tex., was completed and put in operation. At Annandale, N. J., the Annandale Graphite Corporation operated during the first part of the year and then closed down to install new equipment. Standard Graphite operated its plant 15 miles north of Los Angeles. Crystal Graphite, Dillon, Mont., produced only a small quantity, but considerable attention was given to the development of new orebodies and carrying on experiments in graphite refining.

Of the amorphous graphite companies, the most important was Detroit Graphite, which operated its mine at L'Anse, Baraga County, Mich., and produced about 1,000 tons of material which was pulverized to 325-mesh fineness and used in the manufacture of paint. The only mine operating in Rhode Island was Anthracite Superfuel, near Sockanosset. Prices of graphite remained remarkably uniform throughout 1928.

Asphalt

By Prevost Hubbard

HEALTHY, normal conditions prevailed in the asphalt industry during 1928, and total production probably exceeded that of 1927, which was an exceptionally good year for the industry. Nearly 80 per cent of the total annual output of asphalt, which is about 5,000,000 tons, is now produced at petroleum refineries. About 800,000 tons of rock asphalt (bituminous rock) was produced in 1927, representing an increase of more than 18 per cent, as compared with the record for the preceding year. Although no production figures are available as yet for 1928, tonnage for the year will probably be about the same as that of 1927. Output of mined asphalts will undoubtedly vary proportionally with the production of petroleum asphalts.

The major use of asphalt continues to be in road and pavement construction and treatment, and apparently in the near future an enormous increase in consumption will result from its extensive use in the development of secondary roads. These roads comprise one of the most important problems confronting federal, state, and county highway organizations. Exportation of asphalt, primarily for highway purposes, has already developed into an important business. In 1927 it accounted for about 10 per cent of the total production, and for 1928 a substantial increase is expected. During the last few years the roofing industry, second in importance from the standpoint of asphalt consumption, has experienced a slow growth, and no radical change took place in this field during 1928. Employment of asphalt for miscellaneous purposes is receiving increased attention, both in the development of new uses and in its substitution for other less satisfactory or more expensive constituents of a number of products.

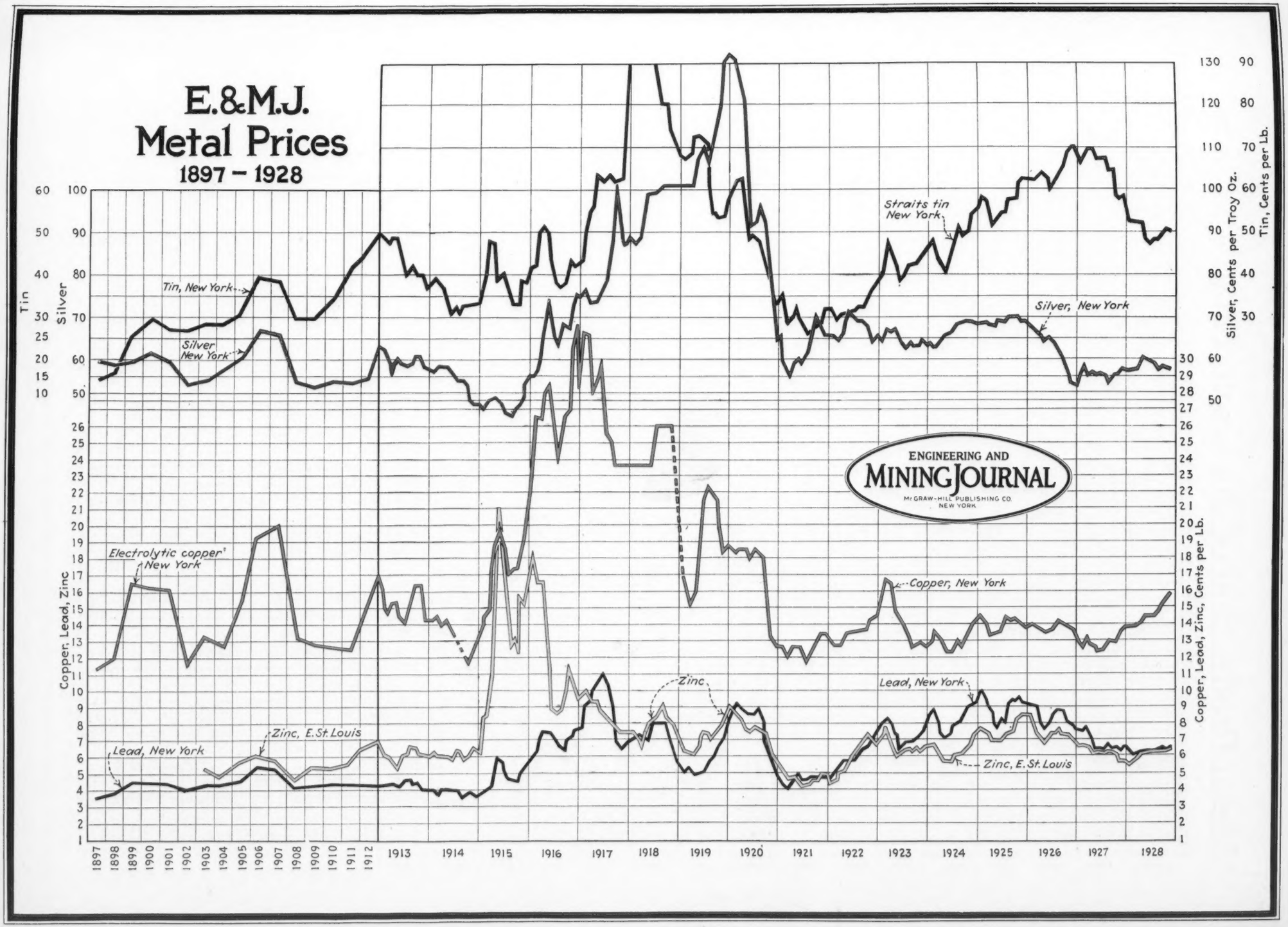
Salt

By Edward W. Brown

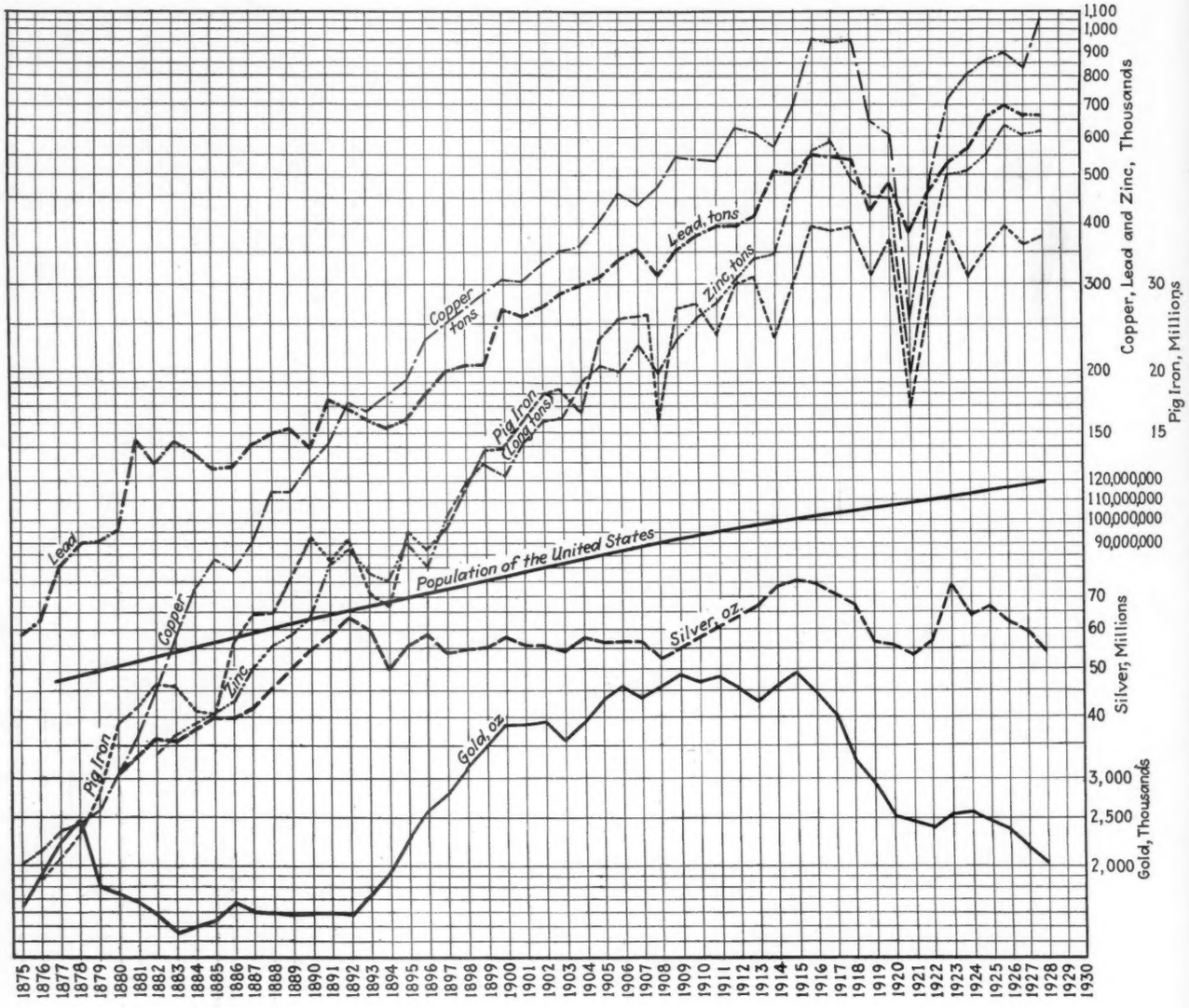
LOW prices for salt during 1928 have prompted producers to make every effort to reduce costs, largely by experimenting with new types of equipment. Investment required for operation purposes is high, about $150 being invested for each $100 of annual sales. Rock salt production involves, first, the sinking of a shaft and erection of a breaker, then blasting the salt from the faces developed, loading into cars, transporting to shaft foot, hoisting to the breaker, and crushing and screening to market sizes, which range from about the size of peas to the size of sand. The coarser grades are used largely by the ice-cream trade, the decreased demand of which has necessitated, in many cases, the installation of additional crushing machinery to reduce the coarser grades to finer sizes. Improvements in undercutting machines have permitted increasing the depth of kerf from 7 to 8 ft., and experiments are being made with machines cutting to 9 ft.

Tendency of some producers in 1927 to dump their product at unremunerative prices outside of their natural territory has diminished somewhat during 1928, and prices are more nearly stabilized in the southern and western sections.

Consumption of salt during 1928 was about the same as in 1927. The industry is characterized by potential overproduction in all sections of the country where there are salt mines.


E.&M.J.
Metal Prices
1897 – 1928
Tin
Silver
Copper, Lead, Zinc
Silver, Cents per Troy Oz.
Tin, Cents per Lb.
Copper, Lead, Zinc, Cents per Lb.
Tin, New York
Silver New York
Straits tin New York
Silver, New York
Electrolytic copper New York
Copper, New York
Zinc
Lead, New York
Zinc, E. St. Louis
Lead, New York
Zinc, E. St. Louis
ENGINEERING AND
MINING JOURNAL
McGRAW-HILL PUBLISHING CO.
NEW YORK

Metal Production of the United States, 1875 to 1928



Yearly Average Prices of Principal Metals, 1899-1928

Prices in New York or St. Louis, cents per pound, except quicksilver (dollars per flask); silver and platinum (dollars per ounce). London quotations, pounds sterling per long ton

Year	Copper: Electrolytic New York	Copper: Standard London	Lead: New York	Lead: London	Tin: (b) New York	Tin: (a) London	Zinc: New York	Zinc: St. Louis	Zinc: London	Antimony, New York	Quicksilver, New York	Silver, New York	Platinum, New York
1899	16.67	.....	4.47	14.933	25.12	122.429	5.75	.....	.....	9.430	43.63	59.580	15.22
1900	16.19	.....	4.37	16.987	29.90	133.575	4.39	.....	.....	9.500	51.00	61.330	18.09
1901	16.11	.....	4.33	12.521	26.74	118.633	4.07	.....	.....	8.250	47.00	58.950	20.00
1902	11.626	52.460	4.069	11.262	26.79	120.720	4.84	.....	.....	6.120	48.03	52.160	19.00
1903	13.235	57.970	4.237	11.579	28.09	127.320	5.40	5.191	.....	6.000	41.32	53.570	18.91
1904	12.823	58.884	4.309	11.983	27.99	126.733	5.100	4.931	.....	6.371	41.00	57.221	19.50
1905	15.590	69.465	4.707	13.719	31.358	143.083	5.882	5.730	25.433	10.250	38.50	60.352	20.34
1906	19.278	87.282	5.657	17.370	39.819	180.646	6.198	6.048	27.020	21.730	40.90	66.791	28.04
1907	20.004	87.007	5.325	19.034	38.166	172.638	5.962	5.812	23.771	14.840	41.50	65.237	30.98
1908	13.208	59.902	4.200	13.439	29.465	133.124	4.726	4.578	20.163	8.004	44.84	52.864	16.32
1909	12.982	58.732	4.273	13.042	29.725	134.774	5.503	5.352	22.185	7.466	46.30	51.502	24.87
1910	12.738	57.054	4.446	12.920	34.123	155.308	5.520	5.370	23.050	7.386	47.06	53.486	32.70
1911	12.376	55.973	4.420	13.970	42.281	192.353	5.758	5.608	25.281	7.540	46.54	53.340	43.12
1912	16.341	72.942	4.471	17.929	46.096	209.420	6.943	6.799	26.421	7.760	42.46	60.835	45.55
1913	15.269	68.335	4.370	18.743	44.252	201.679	5.648	5.504	22.746	7.520	39.54	59.791	44.88
1914	13.602	61.524(c)	3.862	19.076(c)	34.301	156.564(c)	5.213	5.061	22.544(c)	8.763	48.31	54.811	45 14
1915	17.275	72.532	4.673	22.917	38.590	163.960	13.230	13.054	67.533	30.280	87.01	49.684	47.13
1916	27.202	116.059	6.858	31.359	43.480	182.096	12.804	12.634	72.071	25.370	125.49	65.661	83.40
1917	27.180	124.892	8.787	30.500	61.802	237.563	8.901	8.730	52.413	20.690	106.30	81.417	102.82
1918	24.628(d)	115.530	7.413	30.100	(e)	330.138	8.159	7.890	54.180	12.581	123.47	96.771	105.95
1919	18.691	90.796	5.759	28.590	63.328	257.601	7.338	6.988	42.879	8.190	92.15	111.122	114.61
1920	17.456	97.480	7.957	37.832	48.273	295.866	(e)	7.671	44.372	8.485	81.12	100.900	110.90
1921	12.502	69.356	4.545	22.752	28.576	165.265	(e)	4.655	25.845	4.957	45.46	62.654	75.03
1922	13.382	62.123	5.734	24.097	31.831	159.450	(e)	5.716	30.003	5.471	58.946	67.521	97.618
1923	14.421	65.840	7.267	27.147	41.799	202.148	(e)	6.607	33.058	7.897	66.502	64.873	116.537
1924	13.024	63.149	8.097	34.421	49.674	248.737	(e)	6.344	33.728	10.836	69.761	66.781	118.817
1925	14.042	61.920	9.020	36.429	56.790	260.974	(e)	7.622	36.624	17.494	83.128	69.065	119.093
1926	13.795	57.971	8.417	31.075	63.615	291.016	(e)	7.337	34.105	15.988	91.903	62.107	113.269
1927	12.920	55.653	6.755	24.192	62.747	288.953	(e)	6.242	28.513	12.393	118.159	56.370	84.636
1928	14.570	63.703	6.305	21.060	(e)	227.131	(e)	6.027	25.284	10.305	123.506	58.176	78.580

(a) Prices of tin, London, from 1899 to 1914 from statistical report of Metallgesellschaft, Frankfurt-am-Main. (b) 99 per cent tin. (c) Average for nine months, no quotations being made during August, September and October. (d) Average of eleven months, no quotations being made in December. (e) No average computed.

Antimony

By K. C. Li

ALTHOUGH full particulars of 1928 operations are not yet available, it is estimated that the world's production of antimony for 1928 will be about the same as in 1927, or about 21,000 gross tons. China again was the most important producer, but not quite to the same extent as in 1927, when the output was estimated at 90 per cent of the world's production.

Mexico and Belgium, both considered high-cost producers, increased their output materially during 1928. Although definite figures for these countries have not as yet been announced, it seems remarkable that production should have increased greatly when the average price of the metal for 1928 was only slightly over 8c. per pound in bond, c.i.f. New York.

Germany is still producing high-grade electrolytic antimony in limited quantities, and the output in that country during 1928 is estimated at about 300 tons. Production in the United States during the year was limited. A small tonnage of antimony ore was mined in Utah and Arizona, but on account of the low market levels these operations were not profitable.

The market in 1928 was unusual in that price fluctuations were not as wide and violent as in previous years. This can be attributed partly to the absence of especially disturbing elements in China to interfere with production and shipments, such as have often occurred in that country in recent years prior to the establishment of the Nationalist government.

Opening in 1928 with a price of 10⅞c. per pound, duty paid, f.o.b. New York, the market reached a high for the year in the latter part of October, when spot antimony was quoted at 11¾c. per pound, duty paid. The approximate average price for the year was 10¼c. per pound, duty paid, equivalent to 8¼c. per pound in bond, the United States customs import duty being 2c. per pound. Less trading activity in the metal prevailed in 1928, because many of the old-established traders and dealers found it unprofitable to continue in the business.

Consumption of the metal in the United States during the year was not quite as large as in 1927, owing principally to a lessened demand for radio batteries, the battery plates of which generally contain antimony. The fact that 1928 was a Presidential election year also had its effect on business, and made consumers cautious in their commitments. General opinion of the trade is to the effect that consumers are pursuing a hand-to-mouth policy, and are carrying practically no stocks. In prior years, consumers purchased their requirements several months in advance, and kept stocks on hand, because considerable time is involved in shipping antimony here from China. The latter method insures a regular supply, but it, too, has drawbacks as well as advantages. The fact that consumers are not stocked up with antimony is a healthy sign, and the outlook for 1929 is for an increased demand and higher prices.

Nickel

By Thos. W. Gibson

WORLD requirements of nickel are supplied chiefly by two fields—namely, the Sudbury field in Ontario, and that on the French island of New Caledonia. More than 90 per cent of the total production comes from Sudbury. For the first nine months of 1928 the output of the Sudbury smelters was 64,580 tons of matte containing 30,913 tons of nickel and 20,732 tons of copper. This is equivalent to 41,217 tons of nickel and 27,642 tons of copper for the entire year. In 1927 the corresponding annual figures were 39,623 tons of nickel and 25,969 tons of copper. During the first six months of 1928 the New Caledonian output was about 40,000 tons of nickel ore and 1,700 tons of nickel matte.

An interesting development has altered to a considerable degree the outlook of the Canadian nickel mines. The largest known body of ore is contained in the Frood mine, the ownership of which is divided between International Nickel and Mond Nickel. The boundary line between the holdings of these two companies crosses the deposit. Comparatively low-grade ore was found at the surface of the mine, but diamond drilling to a depth of more than 2,000 ft. showed that the nickel content improved up to 4 per cent, and that of copper to 17 per cent. The size of this valuable orebody has not as yet been fully determined, but figures available are impressive. The Mond shaft has been sunk 3,350 ft., and levels have been started at 2,800, 3,100, and 3,300 ft. At 2,800 ft. the ore is 100 ft. wide, and the north drift is in ore for 820 ft. Both faces of a crosscut at the north end of the drift have been in ore 100 ft. On the 3,100 ft. level parallel drifts about 45 ft. apart are in solid ore. The International shaft, now at 3,000 ft., is equipped to handle 10,000 tons of rock and has levels at 2,000, 2,400 and 2,800 ft. Crosscuts are being driven to tap the orebody. Considerable platinum, palladium, gold, and silver are also present in the ore. Indeed, the Frood mine is expected to yield silver at a rate which will materially help to offset the current decline in the Cobalt silver field.

International is erecting a concentrator and a new smelter at Copper Cliff, the latter having a stack 500 ft. high, and at Port Colborne the second and third refinery units are being constructed with a view to increasing the output of nickel and copper. At Coniston, the Mond Company is providing additional facilities for ore treatment. The future of these Sudbury companies will probably be influenced more by copper than nickel. An amalgamation of the two concerns has been under negotiation for some months; a deposit like the Frood can be worked to better advantage and more economically by one company than by two.

Hitherto, International's chief supply of ore came from the Creighton mine, where the ore is unusually rich in nickel; the property contains large reserves. The Mond Company is working both the Levack and Garson mines in addition to the Frood. In other parts of the nickel field the Falconbridge, Mount Nickel, and Foy Offsets orebodies are under development by independent companies.

Kaolin

By R. T. Vanderbilt Co., Inc.

SHIPMENTS of china clay and ball clay during 1928 were about the same as in 1927. Domestic production will probably show an output of 600,000 short tons and imported clay will total about 400,000 short tons.

A small increase in the production of American plants was due partly to increased total consumption and partly to a displacement of further quantities of imported grades. Production in South Carolina particularly increased markedly; additional capacity is being installed there and also in Georgia. All of the production is coming from the established fields, and no new discoveries of importance occurred during 1928.

Progress was made in improving known grades by further refining, such as pulverizing, tinting, and bleaching of the standard qualities, and considerable technical control has been achieved by the larger companies. More and more clay is being used in the pulverized form, the large consumers installing pneumatic unloading systems, which are particularly economical for unloading and conveying purposes. Use of American grades increased in the ceramic industries, and this consumption is expected gradually to increase further as potteries become accustomed to the changes necessary in substituting American grades for imported clay.

All of the production increases which have occurred during the last few years together comprise a substantial growth in the American industry. The industry continues to be highly competitive, with low prices and an overcapacity for production prevailing.

Production in 1929 will be determined by general business conditions and must be governed by consumption in the industries using clay as a raw material, as no new uses are apparent.

Manganese

By Charles Hardy

THE outstanding event in 1928 affecting the manganese situation was the surrender by the Harriman interests of their concession in the Caucasus. According to reports from Europe, the sale of Caucasian manganese ore is now in charge of Manganese G. m. b. H., a Berlin company. This concern is said to have entered into an arrangement with Rawack & Gruenfeld, of Berlin, whereby the latter, which handles Nikopol ore, is also sales agent for Caucasian ore. Friction and competition should, therefore, be eliminated as far as the Russian producing field is concerned.

Consumption of manganese ore per ton of steel remained about stationary. Potential production of the principle ore fields is far greater than consumption, and for many years no shortage is possible. Russian production is capable of expansion by many hundreds of thousands of tons. Indian output has been considerably greater than shipments, and indications are that a considerable stock has accumulated.

Equipment of port and plant at Takoradi, Gold Coast, Africa, was completed during 1928 and increased shipments from the district, which is apparently the cheapest producer, may be expected during 1929. Egyptian ore, which has a low manganese content that can be held below the 30 per cent duty-free limit of the United States, is finding a wider and wider market. At Macry, Turkey, where manganese deposits of importance are exploited, aerial transportation lines were built, and this field should also contribute toward the manganese supply in 1929. The Brazilian situation remains unchanged.

In the United States, the American Manganese Producers Association has strongly advocated the development of domestic manganese resources; in many quarters efforts are being made to utilize known deposits. Montana continues to produce an appreciable amount from rhodochrosite ores, but, although actual production figures are not as yet available, domestic output from all quarters is not expected to exceed 10 per cent of the total requirements of the country.

Manganese has been considered one of the key metals in a national emergency, and the commission appointed by the government to study the manganese situation submitted a recommendation that a considerable stock be carried in this country at all times. Such a stock if bought at ruling prices, and after many years of carrying charges, would not reach the value that the steel companies were forced to pay during the last war. Although no action has been taken on this recommendation, it would appear that Europe has adopted a policy of this character—that is, if the disproportion of imports into England, France, and Germany to the annual requirements of the steel industries of these countries is indicative.

Consumption of manganese dioxide is diminishing rapidly, chiefly because dry cells for radio use have been replaced to a large extent by house current, and owing to the elimination of dry cells in automobiles. Prices for manganese ore, as a result of close control by producing companies, have been maintained during the last year. With the outlook for the steel industry continuing its present rate of production both here and abroad, an undiminished manganese consumption should prevail in 1929.

Quicksilver

By H. W. Gould

THE price of quicksilver during 1928 eclipsed by a small margin the record high price of the metal in 1927, actual sale prices in 1928 ranging from $115 to $135 per flask. Production in the United States during 1928 increased considerably over the 1927 output of 11,276 flasks, reaching a total of about 17,000 flasks. Although world figures are not as yet available, production for 1928 will undoubtedly be the greatest ever recorded and will be about 150,000 flasks.

The greatest increase was again at the Almaden mine, in Spain, which increased its production from 52,500 flasks for the season ended June 1, 1927, to more than 74,000 for the last season, which closed June 1, 1928. Output in Italy improved to about 64,000 flasks, the gain coming mostly from the Monte Amiata district. In the United States, the industry flourished, and a more prosperous condition prevailed than at any time since 1916. Old mines reopened and new prospects were found. New plants have been built, and production is increasing. The New Idria mine, in San Benito County, Calif., continued to be the largest producer in the country, although closely followed by the Friedman property of Nevada Quicksilver, in Nevada, and several others. Apparently the United States will once more take its position as one of the principal quicksilver producing countries of the world, and I look for a substantial increase in domestic production during 1929.

No great change was made in the metallurgy of quicksilver during 1928, though many refinements in the present standard rotary furnace have been effected, especially in the all-metal condensing system and the cyclone dust precipitators. The new rotary furnaces, equipped with steel ore bins, firing hoods, headers, dust precipitators, and metal condensing systems, compare favorably with metallurgical equipment used in other mining industries. Recovery and working costs are satisfactory.

The most important feature in the quicksilver market during 1928 was the consolidation of sales made by Italian and Spanish producers through their respective governments. This action, in effect, results in the formation of a trust or cartel, inasmuch as Spain and Italy produced in 1927, the last year for which complete figures are obtainable, 90 per cent of the world output of quicksilver. This "trust" is controlled directly by the Spanish and Italian governments, as the Spanish government has under its supervision all production in that country and the Italian government, operating the Idria mine, produces a considerable portion of the Italian metal. Production, however, will be curtailed to keep prices at a high level.

The market situation is extremely good and more assurance that high prices will continue is evident than ever before. I expect 1929 to be the best year that American quicksilver producers have ever had.

Aluminum

By S. A. Hartwell

PRODUCTION of aluminum in the United States in 1928 will show a gain over the record for 1927. Probably the most interesting development now in consumption is to be found in the transportation industry, which embraces land, sea, and air transport. Use of aluminum and its strong alloys in the construction of railway and street railway cars, freight containers, commercial truck bodies, ships, airplanes, and lighter-than-air craft offers a solution to the problem of how to increase pay loads, lower operating and maintenance costs, and, at the same time, obtain strength and durability in such equipment. In 1927 the Alclad alloy sheet was first placed on the market, and sufficient and varied applications have been made to indicate that it is highly successful. Aluminum chairs are now being extensively manufactured, and their undoubted advantages and superiorities are generally recognized. An increasing number of railroads are adopting them as standard equipment for dining cars; installations have also been made in offices, libraries, and cafeterias. Shingles and roofing accessories of aluminum are now in use in most sections of the country; and, in addition, aluminum spandrels, grill castings, and exterior ornamental pieces.

Aluminum powder for paint pigment continues to find a ready and increasing market, not only industrially but also in the home. It makes an excellent priming coat for wood, its high waterproofing qualities giving it a distinct advantage over other types of paint. Consumption of aluminum foil in 1928 in the United States will total about

6,000,000 lbs. It is employed for wrapping yeast cakes, candies and chewing gum, in the manufacture of condensers, and for numerous other purposes.

More aluminum is consumed by the automobile industry than by any other. This is not surprising when its extensive use for engine castings and forgings alone is considered. For instance it is estimated that in 1928 over 20,000,000 lb. of aluminum pistons were produced, both as original equipment and as replacements. The second highest consumer was the cooking-utensil and household-appliances manufacturing industry; and the third, manufacturers of electrical conductors, which include steel-reinforced aluminum cable, all-aluminum cable, and busbars. Fourth were jobbing foundries, which serve a wide field, their output going to many different industries. Fifth in rank were the steel metallurgical industries, which consumed a large tonnage in the form of granulated aluminum ingot, grained ingot, notch-bar ingot, and rod.

Prices remained firm throughout 1928, and demand was steady. Aluminum and its alloys are finding ever wider and more varied uses throughout all industries, and the prospects for the future are encouraging.

Tungsten

By Frank L. Hess

IF THE importance of tungsten depended on large and cheap production, as does that of the common metals, it would occupy an inconsequential place among mineral products, but its use in incandescent lamps and in tools for cutting metals and other materials shaped with difficulty makes such enormous savings that its value in the economic structure places it in a class with lead and zinc and below only iron and copper.

During the year 1928 producers of the United States sold an equivalent of about 1,290 short tons of concentrates carrying 60 per cent tungsten oxide for about $761,000. About 180 tons of the total was sold from stocks. For 1927 the sales were 1,164 tons, valued at $794,000. Figures for imports to Oct. 31, 1928 (subject to revision), showed 1,991,786 lb. of tungsten in ore and 59,916 lb. in artificial forms, equivalent to about 2,100 tons of 60 per cent concentrates. At the same rate the imports for the entire year would be about 2,500 tons. On the last of October an equivalent of about 930 tons of 60 per cent concentrates was held in bond, a reduction of nearly 550 tons during the year.

As in 1927, the Nevada Massachusetts Company, near Mill City, Nev., was the largest producer of tungsten and mined scheelite from contact metamorphic deposits. Atolia Mining at Atolia, Calif., was the second producer, and concentrated scheelite from the semi-residual placers formed from its veins, from old dumps, and from the veins. In Round Valley, near Bishop, Calif., J. Paul Jones mined scheelite from contact metamorphic rocks. Only Tungsten Production and Wolf Tongue Mining in Boulder County, Colo., mined tungsten ferberite. In South Dakota Homestake Mining mined wolframite until Nov. 1, when the mine was exhausted. Small quantities of wolframite were mined at Tip Top, Ariz., and near Silvermine, Mo.

China continued to be the most important of the tungsten-producing countries, but little data were available concerning the year's output. Burma and the Malay Peninsula produced tungsten concentrates as a byproduct of tin mining. In Bolivia some tungsten was mined toward the close of the year.

Prices in the United States ranged between $10 and $11.25 for concentrates of good quality. Many tons of concentrates contained only 28 to 55 per cent tungsten oxide and prices for the lower grades were as low as $4.25 per unit. World price ranged from $3.25 to $4.00 per long ton unit (22.4 lb. of tungsten oxide) for concentrates carrying 65 per cent or more tungsten oxide.

Three features marked the tungsten market during 1928: An investigation of the tungsten industry by the Tariff Commission; continuation of efforts to have a duty levied on the tungsten contained in steel scrap; and, perhaps more important, the tungsten alloy "carboloy" was placed on the market.

The investigation of the tungsten business was ordered by a resolution of the Senate, and was immediately taken up by the Tariff Commission. It was still under way at the close of the year.

During 1928 a few hundred tons of scrap steel carrying tungsten was imported, all below the value of 7c. a pound, to which limit a duty of 75c. a pound applies. Efforts are being made to have the tungsten-bearing scrap declared a tungsten steel, which should pay a duty of 8 per cent ad valorem, and also to have a duty of 72c. per pound levied on the tungsten content in excess of six-tenths of 1 per cent.

Carboloy, a trade name for a tool material, which is the result of years of research to make available the exceedingly hard but brittle carbide of tungsten, was placed on the market by the General Electric Company, through its subsidiary, the Carboloy Company, Inc. A tungsten carbide carrying about 6 per cent carbon is ground in a ball mill with a small percentage of cobalt to an exceedingly fine powder. In the process, iron is ground from the ball mill and enters the batch, which is pressed into shape, sintered electrically, and then made into cutting edges for tools. When finished it appears quite as metallic as the remainder of the tool. It is brazed to the tool with copper by the atomic hydrogen flame. Carboloy will cut chilled castings, rough sand-castings, unevenly tempered steel, glass, porcelain, and even quartz. At high speeds it will also cut hard rubber, bakelite, and mycalex (fine mica in lead borate), which quickly destroy the edges of high-speed steel tools. Although prophecy is always dangerous, carboloy seems to be the greatest advance in metal-cutting tools since the invention of high-speed steel. What its influence will be on the tungsten industry is equally difficult to gage, but usually increases in quality mean, in the long run, increases in the quantity of material used.

Hastellite, a hard alloy of tungsten, chromium, and carbon, which is a development of stellite, was also placed on the market in 1928 as edges for steel tools and as irregular grains which are used in place of carbons in rotary drills.

Barytes

By S. W. Thompson

EXISTING conditions, for both producer and consumer of barytes ore, are almost normal. Stability prevailed, generally speaking, in the lithopone and chemical industries during 1928, and the general outlook for the future is no less encouraging. There is a wider use for barytes than in former years. Trend of demand is toward a higher quality of virgin ore and a preparation better suited to consumers' needs. This applies to the barium content, as well as to freedom from all inerts, and the crushing of crude ore to a size suitable for manufacturers' use. The economic reason for the steady increase in the consumption of American barytes is that producers in this country have adapted their plants to quality as well as quantity production.

Uses of barytes have increased until at least 25 important derivatives from crude barytes ore are now marketed. Among these are barium sulphide, barium nitrate, barium chloride, barium metal, barium acetate, barium sulphite, barium fluoride, barium peroxide, barium sulpho-cyanide, and other barium salts. Both the producers and consumers have been benefited by the results of mechanical and chemical research.

Although a large tonnage of ore has been mined during the last few years, production in the United States during 1928 will probably show an increase totaling about 255,572 tons. Most of this output came from Missouri and Georgia, the tonnage from Georgia being about 100,000 tons. Surveys and prospecting have indicated in that state a 25 years' supply of ore at the present rate of extraction. Deposits in various other states that are as yet unmeasured, owing chiefly to their distance from railroad facilities, indicate that supplies are available to meet demands for many years to come.

No one can gainsay that the barytes industry is coming into its own. It affords a large demand for labor and for machinery and electrical appliances.

Asbestos

By Norman R. Fisher

WORLD output of asbestos for 1928 was considerably in excess of that for any previous year, owing chiefly to increased production from the newer fields. In 1927, total output amounted to 373,000 tons, having a gross value of $20,000,000. Total production for 1928 should amount to about 400,000 tons, valued at $24,000,000.

Canada is still the largest producer of asbestos, but during the last two years output there has been almost stationary, whereas that of the newer fields, particularly those of Africa, has been increasing steadily. Canada's output in 1928 will represent about two-thirds of the total tonnage and about half of the total value of the world's output.

In 1927, Canada sold 274,778 tons of all grades, having a total value of $10,621,013, or an average value of $38.65 per ton. About the same quantity was disposed of in 1928, for a return of about 20 per cent more, owing to the higher prices that prevailed.

Prices for the longer grades, particularly, were higher in 1928 than those of 1927, a condition that was induced largely by a decrease in the production of these grades. Africa, on the other hand, showed a considerable increase in output of the better grades of fiber.

In 1927, Rhodesia produced about 33,176 tons, having an average value per ton of about $116. Production for 1928 should reach 44,000 tons, the average value being about the same as that for 1927. In South Africa, too, the industry is expanding rapidly. In 1926, the Union produced 14,096 tons; in 1927, 22,133 tons; and last year about 27,000 tons, the average value for all three years being about $75 per ton. Current development operations indicate a further increase in production during 1929.

Cyprus also is rapidly increasing its yearly output. In 1926, it produced 6,197 tons; in 1927, 11,200 tons, and in 1928, about 20,000 tons of grades that averaged about $100 per ton in value. Russia, the only other European producer of moment, is gradually regaining its pre-war position. According to figures available, output in 1924 was 8,743 tons; in 1925, 12,669; in 1926, 19,789; and in 1927, 23,699 tons. For 1928, a further increase will apparently be recorded.

The United States produced about 1,350 tons of asbestos in 1926; 3,000 tons in 1927; and about 5,000 tons in 1928. Average value per ton for each of the three years was about $115. Although the present output of the United States is small, indications are that it will increase markedly in the near future.

Average Prices, 1927-28 for Canadian Asbestos

Classification	Twelve Months of 1927	First Six Months of 1928	Present Prices
Crude No. 1	$423.65	$543.90	$700.00
Crude No. 2	249.59	289.50	400.00
Spinning stocks	129.32	132.37	250.00
Shingle stocks	64.81	69.38	80.00
Mill board and paper stocks	37.82	39.48	45.00
Filler, floats and other short fibers	14.73	15.26	17.50

Bismuth

By H. M. Brush

INFORMATION about the bismuth market during 1928 is meager, and much that is available is conflicting. The English syndicate raised its price for bismuth on Feb. 3, 1928, to 9s. per pound from 8s.—its price since April 1, 1927. On July 9, 1928, the price was reduced from 9s. to 7s. 6d. per pound. Thus, at this writing, two changes have been made during 1928 in the syndicate's price, as compared with one change in 1927.

When the change in the English syndicate's price was announced, on Feb. 3, the largest American seller revised its price from 8s. to about $2.10 per pound, the price varying slightly, dependent upon the size of the order. Thus, although the advance in the United States price was about the same as the advance in the English syndicate's price, bismuth was quoted for the first time in this market in dollars rather than in sterling. When reports of the English syndicate's reduction of July 9 were received, the American price fell approximately 40c. per pound, to around $1.70 per pound, or about 4c. per pound more than the corresponding fall in Europe.

The American price for bismuth for the entire year has been under the foreign price plus duty, but in spite of this fact imports still continue. This may be due to long-time contracts still in force, or it may represent a small amount of metal "dumped" here because of the restricted market in Europe.

The Oil, Paint and Drug Reporter indicates imports of about 20,000 lb. during the first ten months of 1928; government figures of imports for 1928 are still unavailable, but it is safe to assume that these will be considerably higher.

Bismuth's principal consumption is still in connection with medicinal salts, and the quantity used in the United States is showing no appreciable change, remaining at about 300,000 lb. per annum. Bismuth is one of the few metals for which no new important uses have been discovered for many years, and without doubt a fortune awaits the man who will discover a new application in which it can be economically utilized at, or about, the present price level.

Oil Shale

By Martin J. Gavin

NO important new developments in connection with oil shale took place in 1928. In the Scottish oil-shale industry, following the curtailment of operations and abandonment of certain retorting units in 1927, shale treatment was maintained at the rate of about 2,000,000 tons per year. The future of the Scottish industry is not at all secure, although the industry has been aided by the imposition of a tax of 4d. per gallon on imported motor spirit. The tone of the chairman's speech at the annual meeting of Scottish Oils on June 11, 1928, was not optimistic as regards the future shale operations of the company. According to latest reports, production and retorting of oil shale in France has continued at about the same rate as in the last few years. In Esthonia, mining of oil shale for direct utilization as fuel in certain industries has continued, and much work has been done on experimental and semi-commercial retorts, but so far commercial production of shale oil has not been obtained. In Manchuria, a Japanese company is said to be constructing a large retorting plant for treating the shales in the Fushun district. This plant should be in operation during 1929.

In the United States, public interest in oil shale has apparently waned, and less is heard of the many small companies organized to promote the development of oil-shale lands or the manufacture and installation of retorting equipment. A plant operated in Wyoming during 1927 was closed down, at least temporarily, after a short period of not entirely satisfactory results. One small plant in Colorado continues to operate intermittently. Statements are heard from time to time of small-scale retorting installations, but nothing noteworthy has been reported. The U. S. Bureau of Mines oil shale experimental plant in Colorado resumed operation in June, 1928, after having been shut down since July 1, 1927. Before starting in 1928, many changes and improvements were made which have greatly facilitated experimental work. The data being obtained will greatly amplify those collected in 1927. Funds available will probably keep the plant in operation until the middle of April, 1929.

Last year I concluded my review of the oil-shale industry with the statement that, "While prices for petroleum products are maintained at the present low figure the prospects for the development of an oil-shale industry in this country are not hopeful." That conclusion still holds. Moreover, with the perfection of processes now being developed for the production of liquid fuels from coal, the outlook for the commercial utilization of our oil-shale resources becomes less hopeful than it has been since 1916.

These conclusions may be upset by an entirely unexpected, but not impossible, decline in the production of petroleum, or by failure of the coal processes to yield satisfactory products at low cost. Oil shale must still be regarded as one of our reserve sources of liquid fuels.

Borax

By G. J. Young
Associate Editor

BORAX dropped to a contract price of $50 per ton delivered in 1928, and some sales were even made at $40 per ton. As a result of these low prices borax is being tried out in many applications where it has advantages, but where its former high price prevented extended use. In the glass and textile industries, and with other consumers of large quantities of alkalies, borax is becoming of interest. A small increase in the consumption during 1928 is expected, and the immediate future holds out good prospects for material increases in demand.

Two groups of borax producers are clearly defined: (1) the kernite producers headed by the Pacific Coast Borax and including Western Borax; and (2) the Searles Lake producers headed by American Potash & Chemical and including West End Chemical and Burnham Chemical. Six producers, therefore, are in active competition, and the demand for their common product is comparatively modest. Production capacity, moreover, is far in excess of demand. The principal borax producers are Pacific Coast Borax and American Potash & Chemical. West End Chemical produced from Searles Lake brines and to a limited extent from its Las Vegas colemanite deposits. Western Borax began shipping in November, and by the end of the year had produced about 4,000 tons. Burnham Chemical is reported to have shipped several carloads from Searles Lake, but the company's operations there are not on a routine basis. The Kramer deposits of kernite have potential productive capacity sufficient to supply all borax requirements for may years. Searles Lake operations have an advantage in that their borax production is a byproduct of potash and soda ash. The present borax demand will be about equally divided between Kramer and Searles Lake operators.

No special technologic advances have taken place recently. According to rumor Pacific Coast Borax will abandon its New Jersey factory and concentrate its factory processes in its California plant. A significant feature of 1928 was the increase in borax exports, which more than doubled as compared with 1927. For the first nine months of 1928 output was reported to have been 57,756 tons, as compared with 24,356 tons for the corresponding period of 1927.

Radium, Uranium, and Vanadium

By Frank L. Hess

THE story of radium, uranium, and vanadium as it concerns the United States has grown shorter with succeeding years. In 1928 no radium was isolated in this country, and only a small quantity of radium ore was mined. In the La Sal Mountains near Moab, Utah, A. W. Balsley mined a few tons of carnotite carrying 5 per cent uranium oxide, and in the White Oaks district 9 miles south of Tyrone, N. M., Leach and Leach mined a few tons of rock carrying autunite and torbernite. All this production was for use in therapeutic preparations.

United States Vanadium, with a mine on East Rifle Creek and an oxide plant on the railroad at Rifle, Colo., 11 miles southwest of the mine, was the only miner of vanadium ore in the year just past. The ore is a fine-grained roscoelite bearing sandstone in which the roscoelite forms flakes in the interstices, and is probably accompanied by minute particles of other vanadium minerals. The oxide was shipped to Niagara Falls for reduction to ferrovanadium. Few details are available concerning production in South Africa and South America, but in the latter country Vanadium Corporation of America continued to hold first position, owing to the production from its Peruvian mines. To the end of October 302 tons of ore, presumably carrying 11 to 12 per cent of vanadium, had been imported from Peru during 1928. Europe's needs for ferrovanadium were apparently covered by South African ores, and in the three months from Aug. 1 to Nov. 1, 173,664 lb. of ferrovanadium, valued at $157,742, was imported from Germany.

Radium from Belgian Congo ores continued to dominate world markets, and according to the annual report of the Union Minière du Haut-Katanga, this company sold 26 grams during the fiscal year ended June 30, 1928. The retail price semed to be about $70,000 per gram. The Soviet government carried on some work on radium ores from Ferghana, and had about 6 grams of radium distributed among various places. The Czechoslovakian government also continued work on the uranium ores mined at Jachymov, Joachimsthal.

Manufacture of apparatus for making radioactive drinking water, of radioactive pads, and salves, besides luminescent watch and clock dials and house numbers, has grown to considerable proportions. A number of deaths have resulted among technical and manual operatives, which, rightly or wrongly, have been ascribed to the effects of radium and mesothorium. A conference was called late in the year by the surgeon general of the Public Health Service to consider the question of health and its connection with radioactive substances.

The most important new use of vanadium is as a catalyst for making sulphuric acid and various organic compounds. In the manufacture of sulphuric acid certain vanadium salts are said to be much more efficient than platinum sponge, are not poisoned as is platinum, and are much cheaper. Catalytic uses will, however, require only small quantities of vanadium, and will not noticeably widen the market.

Mica

By Sidney A. Montague

MICA conditions did not change appreciably during 1928. Most of the demand was satisfied by imports, as domestic mines could not operate at a profit in competition with imports at the present rate of duty on unmanufactured mica. In fact, most of the domestic production was derived as a byproduct in the mining of feldspar, both in New Hampshire and North Carolina, which, as in past years, provide the bulk of the domestic output. During the last part of the year a good market for all sizes and qualities of mica prevailed, and importers' stocks were low at the beginning of 1929. Little change occurred in the general level of prices throughout the year, the natural effect of active competition forcing a slight decline. Production and consumption of ground mica increased somewhat, although prices of both scrap mica and the ground product remained about stationary. A large part of the scrap mica used was imported.

Importations of cut and manufactured mica are increasing, and domestic manufacturers are disappearing as a factor in the supply of certain items, such as disks for fuse plugs and films for radio condensers. Imported material produced by the low-wage labor of foreign countries is being sold in this country at prices far below the domestic cost of manufacture. Not only does the domestic manufacturer suffer from this competition, but it reduces the demand for domestic mica, which could easily supply all of this country's requirements for mica disks and all such small punched parts. If, in the forthcoming revision of the tariff, Congress will substantially increase the rates of duty on unmanufactured mica, cut mica, and manufactured mica, the future outlook will be much improved, as such action will greatly stimulate domestic production, and enable the domestic manufacturer to compete in the market for all mica products.

Fluorspar

By G. H. Jones

THE outstanding event in the fluorspar industry during 1928 was the increase in the customs tariff of $2.50 per short ton, by proclamation of the President on Oct. 17, effective Nov. 16, under the flexible provisions of the tariff act. The facts made evident in the report of the experts of the Tariff Commission more than justified the President's action, and, in a complete revision of the tariff act during 1929, as now proposed, there should be no difficulty, if the data in the report referred to are determining factors, in obtaining additional protection, making the import duty at least $10 a short ton.

Consumption of fluorspar in 1928, including imports, was larger than in 1927, as the steel companies used more than usual. With imports restricted to certain territory east of Pittsburgh, output of domestic producers should increase and their operation costs decrease. Barge service on the Ohio River to the Pittsburgh district, aiding producer and consumer, was resumed.

Early in 1928 washed gravel 85 and 5 fluorspar reached a low and unprofitable price of $14.50 per short ton at Illinois and Kentucky mines. Gradual advances took place, until $17 was reached in October. A firm price of $18 was established for the first half of 1929. The profit at this price is small, but sufficient to justify several small mines in resuming operations.

Anticipating a prompt increase in the tariff, imports during August of 1928 were 7,466 short tons, in September 7,789 and in October 6,929. Imports for the year to Oct. 31 totaled 37,826 tons. For the same reason, and as the Tariff Commission's investigation started early in 1926, imports for 1926 were 75,576 tons, and for 1927 71,616 tons. Much of this tonnage will in future be produced by domestic operators. Domestic producers should be able to meet all demands, as ample supplies are available, and an adequate prices will permit necessary development. The outlook for 1929 is good.

Chromite

By Edward Sampson

THE CHROMITE industry experienced a healthy growth in 1928, although not to the same degree in all its branches. Consumption for refractories and ferrochrome increased substantially, but that of the chemical trade has apparently become stabilized. Standards for chrome are evidently changing, as ore containing 50 per cent or more of chromic oxide is no longer obtainable readily. Main sources of supply for this ore, which is employed in the chemical trade, are Rhodesia and New Caledonia. Those using Rhodesian ore, who formerly demanded more than a 50 per cent chromic oxide, are now satisfied with 46 to 47 per cent ore, and New Caledonia can no longer produce large quantities of ore from the Tiebaghi mine. A single large consumer of chemical ore has, however, secured an independent mine in New Caledonia, as a result of which imports into the United States during the first ten months of the year nearly doubled in 1928, as compared to the same period in 1927. Production of Cuba for the same period more than doubled in 1928, owing to the greatly increased activity of the Bethlehem Steel Company. The ore is of rather low chromic acid content, but is suitable for refractories.

One of the most interesting mining developments of the year occurred in the Transvaal, where substantial deposits of chromite have been found, largely as a result of prospecting for platinum. The first deposits discovered were low-grade, but 45 per cent ore is now being mined, which is acceptable to both the ferrochrome and the chemical trade. The Union of South Africa will undoubtedly become a strong factor in the world market.

As the United States consumes about 60 per cent of the world production of chromite, imports into this country indicate world market trends. Except for Baluchistan and the small output of Russia, the United States draws on all important fields. Total imports were about the same in 1928 as in 1927. Those from Rhodesia fell off considerably, but this decrease was counterbalanced by increased imports from other sources, particularly from Cuba, India, New Caledonia, and the Union of South Africa. Decrease of imports from Rhodesia was due to the large stocks secured by consumers in 1927 to protect themselves from a lack of supply resulting from transportation difficulties on the railroad serving the Rhodesian field. Greatly increased production from new mines, however, indicates increased competition for Rhodesia.

Chromium plating continues to increase, but even with general substitution of chromium for nickel in plating, no marked effect will be noticeable in the chromite industry.

Nitrate

By Huntington Adams

THE Chilean nitrate industry continued to improve in 1928. Production for the ten months to Nov. 1 was 2,583,000 metric tons, equivalent to a rate of 3,100,000 tons per annum—the largest in the history of the industry. About 70 plants are in operation. Toward the end of 1928 an important consolidation was announced, by which Sabioncello absorbs Alianza, Liverpool, and Pan de Azucar. The combined production of this new group was 31,000 tons in October.

Probably the most important development in 1928 was the Chilean government's assumption of control of sales prices and marketing for the members of the Nitrate Producers' Association. For the fiscal year 1928-29 the producers are guaranteed a price of 17s. per metric quintal ($40.80 U.S. Cy. per metric ton), f.a.s. Chilean ports, whereas the government has fixed sales prices for delivery in Europe, the United States, and Japan for the same period considerably below the price guaranteed to the producers for delivery in Chile. Inasmuch as ocean freights alone were quoted for December at $7.20 to $7.40 on a Bordeaux or Hamburg basis, and $5.75 to the United States, per long ton, the price guaranteed by the government is equivalent to a substantial rebate on the Chilean nitrate export tax. The latter amounts to $12.17 per metric ton. American operators who have not joined the association are excluded from the advantage. The policy of the Chilean government appears to be so to regulate prices as to place the Chilean industry in a position to compete with byproduct nitrogen and synthetic nitrogen compounds, even at the expense of government revenue.

Exports for the first ten months of 1928, in metric tons, were distributed as follows:

Europe	1,148,000
United States	868,000
Elsewhere	156,000
Total	2,172,000

Production in October, 1928, totaled 283,200 metric tons. That of the leading companies was as follows:

Name of Company	Nationality of Control	October Production, Metric Tons
Lautaro	Yugoslav-Chilean	69,800
Anglo-Chilean	U. S. A.	34,800
Sabioncello	Jugoslav	31,000
Tocopilla	German	16,100
Loa	British-Chilean	14,600
Tamarugal	British	11,100
Taltal	German	7,500
Rosario	British	6,700
Grace	U.S.A.	6,700

Chilean Nitrate Statistics, 1925-28

Metric Tons and U.S.Cy.

	Production	Exports	Average Price	Stocks, Oct. 31, In Chile	Stocks, Oct. 31, World
1925	2,525,536	2,517,099	$41.00	937,000	1,506,000
1926	2,016,698	1,613,731	49.50	1,307,000	1,830,000
1927	1,614,082	2,377,061	45.50	659,000	1,360,000
1928 (a)	2,583,000	2,172,000	40.80	934,000	1,830,000

(a) January to October, inclusive

Phosphate Rock

By K. D. Jacob

THE marketed domestic production of phosphate rock was about the same in 1928 as in 1927, or approximately 3,200,000 long tons. Relatively little change is to be reported in the tonnage of rock figuring in the export and import trades. Eurcpe continued to take the larger portion of export shipments; but, owing to growing competition from north African producers, particularly in Morocco, the prospects for the future of hclding even a constant share of the European business are far from encouraging, and efforts are being made to develop other foreign markets.

Domestic and export prices of phosphate rock were almost the same in 1928 as in 1927. Quotations for the first week of January, 1929, were as follows, per long ton, f.a.s., or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7; 75 per cent, $6.25; 74@75 per cent, $6; 70 per cent, $4.50; 68 per cent, $4.10. Prices firm.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground, 90 per cent through 200 mesh, 33 per cent P_2O_5, $11.20 per short ton. Brown lump for acid manufacture, per gross ton, $6 on 75 per cent basis; $5.25 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton).

Several thousand tons of Morocco rock was again imported during 1928 into the United States at a price reported to be slightly below the market price for the same grade of Florida pebble. These shipments seem to indicate more of a gesture on the part of the Moroccan producers than the beginning of a definite plan to enter the domestic field.

The world phosphate trade remained throughout 1928 at about the same level as in 1927. No important new deposit was opened up, although considerable activity was reported from Russia in searches for high-grade material and in plans for developing the more favorably situated known deposits.

Taken as a whole, domestic shipments moved satisfactorily. Owing to the increased demand for more concentrated fertilizer mixtures, a good trade developed in the superior grades of rock for use in the manufacture of high-grade superphosphates. Considerable research is being conducted on the possibility of concentrating the low-grade and waste phosphate rock, particularly in the Florida pebble field, and extremely important developments in this connection are to be expected in 1929. During 1928 the U. S. Bureau of Mines released details of experimentation on the flotation of low-grade phosphate ores, by H. M. Lawrence and F. E. DeVaney, published in *Engineering and Mining Journal* of June 30. The results, although not immediately applicable for commercial practice, are said to indicate that flotation gives promise of successful application for the beneficiation of phosphate rock.

In several tests on unground sand, recoveries of from 90 to 95 per cent of the phosphate were reported, giving concentrates of commercial grade, or a product that can be made so by a single cleaning treatment. Reagent consumption has been reduced from the amount previously considered necessary; but no reagent combinations other than those based on oleic acid, sodium cleate, or soaps containing considerable amounts of sodium oleate have been discovered that will effect a separation between the phosphate and the quartz.

Perhaps at no other time in the history of the industry has so much interest been shown in the general subject of phosphate as at the present, and governmental and private agencies are actively engaged in research in its various economic and technical phases. A large blast-furnace plant for the manufacture of phosphoric acid is nearing completion on the property of the Victor Chemical Company, at Nashville, Tenn., and the Armour Fertilizer Works has completed a plant near Columbia, Tenn., for the manufacture of phosphoric acid by the sulphuric acid process, which process is now being used by five companies in the United States for the manufacture of phosphoric acid.

The demand for phosphate rock for the manufacture of various phosphates for technical and industrial uses is increasing steadily, as is also the trade in ground raw rock phosphate for direct use as a fertilizer. Indications are that the domestic phosphate trade will at least have an average year in 1929.

Molybdenum

By B. F. Phillipson

INCREASED production of automobiles during 1928 resulted in a larger use of various alloy steels, including molybdenum steels, by the automotive industry. With the adoption of chrome molybdenum, nickel molybdenum, and chrome nickel molybdenum steels for certain parts, few makes of automobiles are produced today that do not contain at lease some molybdenum steel.

In Europe, consumption of molybdenum has likewise increased, and a number of foreign cars employ molybdenum steel in the manufacture of various parts. The metal is finding considerable favor in the steel and iron-castings industries, and prospects for a larger consumption in these fields are good.

Mining operations were continued throughout 1928, and although large stocks of the metal are held, no change in the scale of operations is expected in 1929. Even though consumption of molybdenum continued to increase during 1928, productive capacity is much in excess of the current demand.

Potash

By C. H. MacDowell

COMBINED imports and domestic production of potash during 1928 aggregated 80,000 tons in excess of those during any previous year. Consumption in the United States was only slightly above pre-war figures, although the world is using 44 per cent more than in 1913. Total world consumption in 1927 was more than 1,600,000 tons, (K_2O), the greatest increases being in France, Holland, Great Britain, and Germany. Holland used one-third as much as the United States, and Germany consumed nearly half the world production.

Prices remained stationary during 1928, the average of all grades being 98 per cent of the pre-war average price; muriate averaged 94 per cent, sulphate 100 per cent, sulphate-magnesia 109 per cent, and kainit 107 per cent of 1913 prices. Domestic production amounted to more than 50,000 tons of potash, or one-sixth of the total United States consumption. The increased output was due to larger operations in California, particularly at the Searles Lake plant, where potash is being made into a concentrated muriate that meets fertilizer manufacturers' growing demand for more concentrated mixed fertilizers. Importation of low-grade salts has steadily decreased, a result not only of the higher unit cost, but primarily owing to the need of more concentrated raw material. In 1913 large quantities of 12 per cent kainit were imported, but the amount consumed here now is almost negligible. Production of potash in the sulphate form has not kept pace with the muriate demand; its use is confined largely to the citrus and trucking sections of California and Florida. German and French producers have enlarged their propaganda force in this country, and are now employing, according to reports, about 50 field men.

World production of potash is steadily increasing, and the United States is apparently a fertile field for absorption of surplus output. Efforts are still being made to develop the Texas and New Mexico potash deposits. Enlargement of Searles Lake production is dependent on the ability to market the increased borax output, so that the prospect of complete independence of foreign importation is not encouraging. Besides Germany and France, Poland is endeavoring to increase production. Last year Poland produced over 50,000 tons of potash, and, according to reports, an effort is being made there to finance larger developments in the near future. Reports are meager from Spain, where high costs have retarded increases in production. Russia is producing carbonate of potash at the rate of 3,000 tons a year from dried sunflower seeds, but has not as yet developed the natural potash deposits of the country.

Mining Practice

By George J. Young
Associate Editor

NOTEWORTHY among the events occurring in the mining industry during 1928 were several mine fires; two underground with loss of life, and one above ground with loss of mining plant but no loss of life. These three occurrences made prominent the subject of mine fire prevention. F. C. Gregory[1] discusses fires and fire prevention in Lake Superior mines in considerable detail, and his analysis is worth the attention of mine managers. K. L. Mitchell[2] treats in a general way the circumstances under which mine fires start.

An excellent insight into the manifold phases of a large mining organization is presented in the series of articles that appeared in the Phelps Dodge issue of *Engineering and Mining Journal* dated Oct. 27, 1928. Satisfactory co-ordination of such a number of operating mines involves large-scale financing, purchase of equipment and supplies, transportation, and milling and smelting of ores, and can be achieved only by efficient management. Thus the value of such a series of articles is to point out the methods that experience under capable management has developed. At the other extreme are the conditions brought out by Robert Livermore[3] in his account of prolonging the life of the Smuggler Union enterprise. Here is the situation of a property in its last stages, and the working out of a set of operating conditions under such circumstances is of interest. In open-pit mining, the employment of a new 15-yd. electric shovel shows the trend toward the use of larger units with greater radius of action and higher dumping level. Completion of the electrification of the Utah Copper mine by the addition of electric motor haulage on the benches in place of steam indicates that excavation and haulage in open-pit mines where tonnage is important will be on an electric power basis. Simplification and economy in operation and maintenance are the factors that induced this change in equipment.

Boring

Although diamond drilling continues to hold its place for exploration in mining, few developments have been recorded other than the adoption of certain hard alloys for bits to be used in soft formation. Considerable progress has been made in deep-hole boring with rotary and rope drills in petroleum mining. The record seems to be the 8,255-ft. well of Texon Oil & Land Co. situated at Santa Rita, Tex. In California the Chanslor-Canfield bottomed a well at 8,201 ft. These are remarkable records. An ingenious instrument for bore-hole surveying was described by L. B. Wright.[4] Radioactive material attached to the compass element records positions upon a sensitized photographic strip. The instrument obviates the use of fluids and has the advantage of simplicity.

Mining Methods

An excellent review of mining methods in a series of papers by Charles A. Mitke appeared in *Engineering and Mining Journal*. In Technical Publication No. 136 of the American Institute of Mining and Metallurgical Engineers, Mr. Mitke compares branch raise caving with combined shrinkage and caving methods. He states that the caving methods as practiced on a large scale tend to become less and less distinctive and to gradually merge into one another. Mining methods as applied over a long period in a given mine are subject to simplification in the interest of economy and safe working. There is, therefore, a drift toward similarity in many details in mines of a single region. A brief sketch of mining methods employed at the Broken Hill Proprietary mine is given by E. J. Horwood.[5] Charles H. Foreman[6] describes again Hecla mining methods. Especially significant is the provision for a separate upcast raise to remove used air from the mine instead of resorting to old raises in the stopes. The mine is ventilated by an exhaust fan of 150,000 cu.-ft. capacity; working shafts are downcast. It would appear to be good mining practice to provide for upcast air in a separate shaft which could be designed to serve during the life of the property. Stoping practice at the United Verde Extension is described by Olof Hondrum[7]. This is an interesting application of square-set timbering in small blocks two to three sets wide and from eight to fourteen sets in length. The practice resembles in many respects that at the Bawdwin mine, where conditions are similar. Mining methods employed at the Pilares mine, Nacozari, Mexico, are described by V. A. Brussolo[8], who gives some excellent details, but the methods are not novel and have been described several time before. Likewise, D. C. Mackallor[9] goes over some old ground in his paper on methods in the Tri-State district. It is of interest to note that, as he states, mechanical shovels of various types have been tried in many of the mines of the district, but in almost every instance they have been discarded in favor of hand shoveling. He ascribes this partly to the unfavorable attitude of the men toward their use, and partly to failure to achieve lower costs.

In the non-metallic field, George A. Morrison[10] gives interesting details of limestone mining at the West Penn Cement property in Pennsylvania. Rooms are 35 ft. in width and pillars 25 ft. A V-cut is used, and a vertical height of 17 ft. is broken and extended to room width. When the face has been advanced 27 to 30 ft., a stoper drill is introduced, and 3-ft. holes on 6-ft. centers are drilled to bring down the upper 3 ft. of limestone. Marion Type 7 electric shovels are used for loading. Claude Hafer[11] describes underground mining of trap rock, loading by electric shovel, and haulage by storage-battery locomotives. An interesting account of sandstone mining is given by D. D. Dunkin[12]. George S. Rice[13] and John A. Davis describe mining methods practiced in the potash mines of Germany and France. These are closely related to coal-mining methods. The information presented is of particular significance to miners of large deposits of non-metallic minerals. According to W. J. Fene[14] gilsonite in Utah is mined without explosives and is broken down by pickwork. The broken gilsonite is sacked; little timbering is required, and, as the workings are open to the surface, lights are not necessary.

Explosives and Blasting

Two small books on blasting practice that should be useful to foremen, superintendents, and mining engineers are "Drilling and Blasting in Some American Metal Mines," by Theodore Marvin, and the "Blasters' Handbook," issued by the E. I. du Pont de Nemours & Co. The former discusses details of practice in placing drill holes and blasting, and the latter presents practical information concerning the use of explosives. Research relative to gaseous products from blasting in metal mines appears in a Bureau of Mines bulletin[15]. The authors

[1] Cir. No. 6073, U. S. Bureau of Mines.
[2] Cir. No. 6076, U. S. Bureau of Mines.
[3] *Engineering and Mining Journal*, Vol. 125, p. 525.
[4] *Engineering and Mining Journal*, Vol. 126, p. 57.
[5] *Engineering and Mining Journal*, Vol. 126, p. 295.
[6] *Mining Congress Journal*, June, 1928, p. 381.
[7] *Mining Congress Journal*, June, 1928, p. 385.
[8] *Mining Congress Journal*, May, 1928, p. 343.
[9] *Mining Congress Journal*, May, 1928, p. 247.
[10] *Engineering and Mining Journal*, Vol. 126, p. 210.
[11] *Engineering and Mining Journal*, Vol. 125, p. 737.
[12] Technical Publication 55, A.I.M.E.
[13] Bull. 274, U. S. Bureau of Mines.
[14] Cir. No. 6069, U. S. Bureau of Mines.
[15] Bull. 287, U. S. Bureau of Mines. By E. D. Gardner, S. P. Howell, and G. W. Jones.

state that the oxygen balance of the explosive appears to be a most important factor in connection with the amount of carbon monoxide produced. They also state that results of sampling indicate that the gases produced by blasting are not always the same as those obtained on the Bichel gage. Use of stemming as an aid in reducing the quantity of poisonous gases produced in blasting is advocated.

A paper on liquid-oxygen blasting at Chuquicamata[16] appeared and presented details concerning production, handling, and practice. The cost was 8.5c. for L.O.X. that replaced one pound of dynamite costing 16c. Costs were higher than originally expected, but substantial savings were made in using this explosive, and blasting results in the harder rock of the mine were said to have been entirely satisfactory from every standpoint.

An application of chambering to cut holes of drift rounds is recorded by E. D. Gardner[17]. By lightly chambering, more effective breakage was secured in hard, tough rocks, and a greater depth of round proved practicable. This practice apparently would be applicable only in rocks that break with more than the usual difficulty. S. P. Howell[18] discusses the perennial subject of accident prevention in handling explosives. He advocates a standard method of charging, and, where holes are "ragged," the use of "shot" tubes which prevent displacement and hold the blasting caps in place in the cartridge. He discusses, in particular, the conditions in the Tri-State region.

Mine Support

Few papers on mine support were published. Practice in square-set timbering at the Bawdwin mine is described by R. S. H. Richards[19], who states that at this mine about 98,716 cu.ft. of timber, chiefly native woods, are required per month. He refers to the preserving properties of zinc sulphate in water dripping over shaft timbers. Some timbers in old Chinese workings are in good condition after being in place for more than 50 years.

Sand filling at Modderfontein Deep levels is described by A. G. Barrett[20], who discusses some South African mining difficulties resulting from hanging-wall movement caused by mining over large areas. Methods of timber preservation are given in an anonymous article[21].

In a discussion of the problems that arise in mine examination, Ira B. Joralemon,[22] states that such an examination is simply a process of testing the successive links in a chain of observed facts. As soon as any link is found to be too weak for the purpose which it must serve, the examination is over. He stresses the importance of the interests of the client who engages the engineer. Valuation of alluvial deposits was discussed by W. R. Rumbold[23], and excited considerable discussion, renewing the controversy concerning the number of bore holes per acre. Local conditions determine this important ratio, and experience in any field must be obtained before a trustworthy decision on the matter can be made.

Mine Drainage

In mine drainage, two high-lift pumping stations in the Gogebic range typify present practice under conditions that provide for long-time operation. W. M. Hoen[24] gives the details of both plants which include horizontal duplex pumps driven through gears by alternating-current motors and operating against a 2,000-ft. lift. Air chambers and alleviators are used, as well as automatic control and forced-feed lubrication. Sump arrangements do not appear to have been as satisfactory as other features, although in the Montreal mine a concrete wall divides the sump longitudinally and provides a baffle between the settlement and suction chambers. The provision for using a scraper to remove sediment from the settlement chamber is novel and should prove to be a desirable feature. C. C. Cushwa[25] describes a 300-ft. lift, stage centrifugal pumping station, automatic control, and variable-speed motors. Booster pumps of the deep-well type are used on the suctions. He points out the advantages of this arrangement with respect to the low cost of installation. In his operating costs, labor attendance is 17.6 per cent, power 78.1 per cent, and supplies 4.2 per cent of the total operating cost. Of general interest is a report by W. A. Selvig[26] of tests on non-corrosive metals exposed to acid mine waters. These tests are not conclusive, but are indicative of the variety of high corrosive-resisting alloys available. Apparently "rustless" steels exceed other alloys in resisting the action of the mine waters employed in the tests. Cement grouting[27] in shaft sinking and tunneling has proved of service in the Geduld mine, South Africa, where it was used to seal off fissure water encountered in drifting.

Ore Movement and Transportation

Comparatively little appeared in 1928 relative to ore movement by mechanical methods. C. F. Steinbach[28] presented an excellent paper on the use of scrapers at the Ruth mine. G. H. Booth[29] gives the cost of compressed-air locomotive haulage at Inspiration. Total cost per ton milled is 3.23c.; kilowatt-hours per ton mile, 1.55; and average distance, 0.486 miles. The need for insulated mine car couplings where electric haulage is employed is duscussed by F. E. Cash and C. W. Owings[30], who advocate such devices where explosives are transported. Details of the construction of such couplings are given. Probably some application can be made of them in metal mines.

A report on rock-strata gases in the Cripple Creek district[31] is given by E. H. Denny, K. L. Marshall, and A. C. Fieldner, that attracts attention to this comparatively unusual condition in metal mines. The gases are irrespirable, and are in most cases a mixture of nitrogen, carbon dioxide, and oxygen. They are often heavier than air; barometric conditions influence their discharge. Local ventilation by connections and by power fans are an aid in diluting and sweeping out such gases. Gas masks do not give protection against these gases, but reasonable protection is given by self-contained oxygen breathing apparatus. Further investigation of the explosibility of sulphide dusts in metal mines is reported by E. D. Gardner and E. Stein.[32] Tests indicate that such dusts will produce an explosion, and that blasting in massive sulphides produces appreciable amounts of sulphur dioxide and hydrogen sulphide gases. It is recommended that settled dust be not allowed to accumulate in workings, and that workings be wetted down before loading holes for blasting. The use of stemming is advocated.

Air Flow Resistance

An investigation of the air flow resistance in a small shaft-operated mine by G. E. McElroy and A. S. Richardson[33] points out that calculation of total flows and air distribution in a mine of several levels is a matter of trial. Thus the distribution of air in a large mine becomes not so much a calculation based on theoretical principles as one based on the measurement of air flows and their control by doors and stoppings. A number of papers detailing ventilating conditions in large mines have appeared, but they cannot, because of space limitations, be reviewed here.[34] J. P. Rees[35] discusses methods for the measurement

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[16] *Engineering and Mining Journal*, Vol. 125, p. 536.

[17] Technical Publication No. 61, A.I.M.E.

[18] Serial No. 2855, U. S. Bureau of Mines.

[19] Serial No. 6056, U. S. Bureau of Mines.

[20] Institution of Mining and Metallurgy, February, 1928.

[21] *Journal* of the Chemical, Metallurgical and Mining Society of South Africa, July, 1928.

[22] *Engineering and Mining Journal*, Vol. 125, pp. 613, 655.

[23] Institution of Mining and Metallurgy, May, September, 1928.

[24] *Engineering and Mining Journal*, Vol. 126, p. 364.

[25] *Mining Congress Journal*, March, 1928, p. 172.

[26] *Mining Congress Journal*, May, 1928, p. 339.

[27] *Engineering and Mining Journal*, Vol. 125, p. 60.

[28] *Mining Congress Journal*, Oct., 1928, p. 767.

[29] *Mining Congress Journal*, Feb., 1928, p. 109.

[30] Cir. No. 2868, U. S. Bureau of Mines.

[31] Serial No. 2865, U. S. Bureau of Mines.

[32] Serial No. 2863, U. S. Bureau of Mines.

[33] Serial No. 2890, U. S. Bureau of Mines.

[34] J. B. Pullen, *Mining Congress Journal*, September, 1928, p. 692; G. L. Richert, *Mining Congress Journal*, July, 1928, p. 491; A. S. Richardson, *Mining Congress Journal*, May, 1928, p. 351.

[35] Institution of Mining and Metallurgy, January, 1928, p. 1.

of low air velocities in mines. He describes the vane-anemometer and its calibration. The limitations of the iodine pentoxide carbon monoxide detector are given by G. S. McCaa and J. A. Davis,[36] who point out that the detector does not indicate a deficiency of oxygen in the atmosphere, nor the presence of carbon dioxide and hydrogen sulphide. The detector therefore is inferior to canary birds or mice. When in good condition, it does, however, give a reasonably accurate quantitative determination of carbon monoxide. The Martienssen methane detector described in *Mining and Metallurgy* of February, 1928, is of interest.

The possibilities of applying some of the equipment and ideas developed in commercial air conditioning to mines is brought out by E. G. Lawford.[37] In presenting this thought he states that certain industries in America have for a long time been improving the quality of their factory ventilation by artificial cooling of the incoming air, and that equipment similar to that used in factories is in use at many large motion-picture theaters, in New York and elsewhere. During a July heat wave in New York, the temperature rose to 100 deg. dry bulb and over 79 deg. wet bulb —conditions that caused several deaths from heat stroke among the population; yet it was possible to sit through a three-hour performance in the Roxy Theater, New York City, in a temperature which did not exceed 75 deg. dry bulb and 64 deg. wet bulb—a fact that merits the attention of underground operators acquainted with the discomforts and consequently the low output per man in hot mines.

W. S. Weeks[38] describes the use of a two-fan installation for ventilating mines. One fan supplies the requisite amount of air for general requirements, and the other short-circuits the air in active workings, thus producing local air currents in large volume for local cooling. An approximation to this suggested practice has been in use for many years.

Geophysics

Dr. Richard Ambronn's book on geophysics has been translated and should prove useful to engineers in understanding some of the fundamentals of the subject. Many papers upon geophysics have appeared—too many to list here. The whole subject has reached the interesting stage where opinions are being expressed relative to comparative merits and costs of different methods; the results of experience, both successful and unsuccessful, are being published; and it is freely admitted that further facts are needed before the limitations of various methods will be well understood. More progress, however, has been made during the last several years in developing these methods than in all of the previous ten years. Magnetic surveying was given a fair share of attention. N. H. Stearn[39] discusses the dip needle and the place of geomagnetics in exploration. L. B. Slichter[40] presents an analysis of conditions found in the magnetic survey of a nickeliferous pyrrhotite orebody, and the application of magnetic methods to an area in southwest Wisconsin where great magnetic regularity was found, but no orebodies.

Modern instruments and methods of seismic prospecting are described by C. A. Heiland.[41] Of the several papers upon gravity methods Donald C. Barton's[42] excited the most interest. He states that the torsion balance maps differences in density; that the number of stations necessary to map a structure with a certain degree of accuracy is independent of the size of the structure; that surficial and topographic irregularities, the effects of which cannot be calculated, limit torsion balance surveys; and that the interpretation of geologic structure from gravimetric surveys is as complicated as the interpretation of the probable occurrence of oil from a structural geologic survey.

A greater number of papers on electrical methods appeared in 1928. J. J. Jakosky[43] states that all electrical geophysical methods operate on the same two fundamental principles—namely, the flow of an electric current through a conductive zone, and the detection of that flow of current. These principles may be employed successfully in the self-potential method and various modifications of the applied potential, or ground contact, and inductive methods. The differences between the various methods are mainly in details of field procedure, types of equipment employed, and the effects of local geological and electrical conditions on the equipment. Mr. Jakosky considers that, as a whole, the data obtained from a complete survey by any of the recognized methods will be of real value and help when properly interpreted and applied in the development of a property.

Examples of the application of potential methods to structural studies are given by E. G. Leonardon and Sherwin F. Kelly[44]. Along somewhat similar lines is the paper by Warren Weaver[45]. Karl Sundberg and Allen Nordstrom[46] state that, as a result of certain prospecting work, electro-magnetic prospecting may be employed for finding small veins of poor conductivity in regions of rugged topography. Application of electrical methods in the Ducktown district, where results were correlated with underground workings, is described by T. Zuschlag and W. Koch[47]. In this instance the electric survey was executed over an orebody, one end of which was well opened up by mining and diamond drilling. Results of the survey closely checked known facts as far as location, strength of mineralization, and change of dip were concerned. It furthermore confirmed an assumption relative to the extension of the ore to a certain point, and beyond this point it indicated a sudden decrease in mineralization of the vein that was possibly caused by a fault cutting off the ore.

Failure of electrical methods in the Tri-State area is ascribed by L. B. Slichter to sphalerite as the principal ore mineral, and by A. H. Rodgers to the fact that mineralization is not heavy enough and that the ground water is a good conductor. H. A. Guess stated that the torsion balance had been used in the Tri-State area to indicate flint areas within which drilling might be profitable. In Newfoundland the surface potential method was used successfully and the presence of a considerable tonnage of complex-sulphide ore disclosed. H. T. F. Lundberg called attention to the fact that actual ground conditions are much more complicated than indicated by laboratory research. He pointed out that the ground itself is sometimes a very good conductor, especially in sedimentary regions where the ground is porous and carries solutions that often have a high conductivity and therefore prevent the finding of ore by electrical methods. The need for thorough investigation of these general conditions was stressed. H. D. Hoffman[48] gave as his opinion that the practical use of electrical prospecting is to extend the limits of known sulphide orebodies and that it will be confined to such ores as chalcopyrite and galena, which give positive reactions. The discussions published in Technical Publication No. 130 of the A.I.M.E. are valuable in that they provide an insight into the economics of geophysical methods and the successes and failures attributed to these methods.

Leached Outcrops

An important contribution to the study of leached outcrops was made by Roland Blanchard and P. F. Boswell.[49] The authors point out that the impression should not be gained from their paper that leached outcrop data are useful only in the examination of disseminated chalcocite deposits where application has proved especially successful because the chalcocite limonites are the easiest to interpret, and because more attention has been given to such deposits than to any other type. Owing to the inclusion in investigations during the last few years of the lead and zinc minerals, and the massive types of the copper sulphides, the field for applying leached outcrop data has greatly expanded. The paper is illuminating and the studies should be continued.

[36]Serial No. 6057, U. S. Bureau of Mines.
[37]*Engineering and Mining Journal*, Vol. 125, p. 5.
[38]*Engineering and Mining Journal*, Vol. 125, p. 291.
[39]Technical Publication No. 151, A.I.M.E.
[40]Technical Publication No. 120, A.I.M.E.
[41]Technical Publication No. 149, A.I.M.E.
[42]Technical Publication No. 50, A.I.M.E.
[43]Technical Publication No. 134, A.I.M.E.
[44]Technical Publication No. 115, A.I.M.E.
[45]Technical Publication No. 121, A.I.M.E.
[46]Technical Publication No. 122, A.I.M.E.
[47]*Engineering and Mining Journal*, Vol. 125, p. 890.
[48]Discussion in Technical Publication No. 130, A.I.M.E.
[49]*Engineering and Mining Journal*, Vol. 125, pp. 280, 373.

Ore Dressing

By Charles E. Locke

FROM an economic point of view, mining enjoyed a fair degree of prosperity during the last year, which has enabled companies to carry on research and make alterations and improvements in milling operations. A tribute accrues to the profession in that year after year an annual survey continues to show consistent progress, in all directions, and usually one or more outstanding features. Such achievements for 1928 include more economical crushing, marked progress in flotation, and greater simplicity of flow sheets.

In the crushing field, the Symons cone crusher is now generally accepted as a machine of outstanding merit. With its wide range of reduction, it replaces two or three intermediate crushers and rolls with accompanying screens, and reduces the feed from a coarse crusher to a size suitable to feed to a ball mill or rod mill. It does this with less power, and, it is claimed, with less production of fines. At the Chino mill, a 7-ft. unit reduces 10-in. feed to ⅝ in. at the rate of 200 tons per hour. At Anaconda the same size of unit handles 1,000 tons per hour, but the reduction is from 5 in. to ¾ in. A new 7-ft. unit at Miami receives 14-in. feed and reduces it to ¾ in. at the rate of 300 tons per hour, using a 250-hp. motor. The effect of the Symons cone crusher will be to restrict the field of rolls, and even to bring about their elimination entirely in some plants, as it yields a product fine enough to be fed direct to a rod mill or ball mill. The coming flow sheet will thus consist of a coarse breaker to about 10 in., Symons cone to about ½ in., one or two stages of fine grinding in rod and ball mills to 48 mesh or finer, and one or more steps of flotation. By the use of strong alloy steel, parts of crushing machines may be made lighter in weight; for wearing parts, stellite, which is an alloy containing cobalt, chromium, and tungsten, may have sufficiently long life to offset its high first cost. Several articles concerning the history of disk crushers and rolls appeared in *Engineering and Mining Journal* during 1928.

Among the new developments in ball-milling equipment during the year under review, the Straub rib-cone mill appeared; this has inclined ribs along the periphery, and an end-discharge grate leading to a circumferential screen. The aim of these mills is to produce a more logical agitation of ore and balls in the mill and quicker discharge of finished material. The best evidence available today indicates that the field of rod mills is limited to fairly coarse primary grinding—say down to 14 or 20 mesh; and that ball mills are to be preferred for finer work. Some fine-grinding rod mills have been changed over to ball mills. Larger circulating loads to increase grinding efficiency are being adopted, and loads up to 400 or 500 per cent are commonly claimed, but it is probable that the present average is nearer 200 or 250 per cent. This tendency toward larger circulating loads has necessitated the development of larger and stronger classifiers of the Dorr type, and especially an increase in the raking capacity of these machines. One disadvantage of rod mills is that their circulating loads cannot exceed 150 or 200 per cent without danger. Where two steps of grinding in ball or rod mills are used, best practice is to operate both steps in separate closed circuits in order to secure highest efficiency and economy of grinding. Another scheme for the same purpose is to introduce an intermediate classifier, usually of the Dorr bowl type, after the first stage, to take out finished material from the feed to the second step. The underlying principle involved is to remove finished material as rapidly as it is formed, and thus lessen the production of very fine slime.

With the introduction of fine grinding for flotation came the problem of the great increase in power consumption. Economics of cushing are now receiving well-merited attention. The leading investigation is by the U. S. Bureau of Mines, which has been proceeding for some years and has resulted in three papers.[1] These describe the methods of measurement of the total surface of quartz particles, of correlating the surface measurements to actual screen sizes, with special note on effect of extreme fines, and of measuring the net input of work in crushing in a laboratory device and comparing it with the increased surface of the ore particles. The point has been reached where the net work used in crushing in ball mills can be measured, and data are now being gathered from grinding machinery in the mill at Midvale, Utah. The truth of the Rittinger theory of crushing has been confirmed. This shows that the energy required to reduce a ton of ore from 100 to 200 mesh is greater than all the energy consumed in breaking the ore in the mine and reducing it to 100 mesh, and it also reveals in a startling way the enormous waste of energy involved in the production of particles finer than are necessary for concentration. The practical problem remains to reduce this waste. One thought suggested is that by heating ore to a certain temperature and cooling prior to crushing, lines of fracture will form along the contact surfaces of the mineral ingredients and thus lessen the formation of included grains and very fine particles. Another thought is that it may be possible to use the Fahrenwald machine to float coarser material than that floated at present, making first a bulk flotation product of clean sulphides, together with included grains, eliminating the great mass of waste tailing at this stage, and necessitating fine grinding of only the small amount of bulk flotation product for finished flotation.

Vibrating screens continue in favor. They are claimed to be 20 to 30 per cent more efficient than trommels. On the Leahy vibrating screens punched plate is recommended as having longer life, less cost, and operating at a flatter angle than wire cloth. A 400-mesh testing screen with wires 0.001 in. diameter and holes 0.0015 in. diameter, or 160,000 holes per square inch, is supplied by the Newark Wire Cloth Company.

Improvement in hydraulic classifiers is exemplified by the Fahrenwald classifier and in the mechanical classifiers and thickeners which are integral parts of all modern mills. Dorr classifiers have been improved mechanically, as noted in the foregoing. The bowl type, which makes a better separation than the straight rake type, is recommended for most operations. For dewatering table concentrates Dorr classifiers are supplied with porous bottom and vacuum suction near the upper end of the rake incline. The Hardinge thickeners at the United Verde mill are operated without the bottom filter bed of sand. For filtering, a new automatic rotary filter using the stream-line principle has been developed.

Jigs continue to go into the discard. Finer crushing in Southeast Missouri has now eliminated the last Hancock jig, once a standard machine in the lead mills of that district. Tables are hardly holding their own. An interesting experiment which is under way at the Crawfish mill, at Picher, Okla., is a trial of the Rheolaveur which has been so successful on coal. At Picher it receives a feed ½ in. to 0 and makes a bulk concentrate of lead and zinc to be separated later. Slime goes to flotation. Results are reported to be promising. No outstanding developments have occurred in amalgamation, magnetic separation, pneumatic concentration, or other special processes.

Flotation marches ahead with broader scope, improved technique, and more knowledge of fundamentals. For a concise yet comprehensive picture of flotation today there is nothing better in print than the revised pamphlet by

[1] American Institute of Mining and Metallurgical Engineers, *Technical Publications* Nos. 46, 126, and 127.

Professors Weinig and Palmer,[2] and for a valuable retrospect of flotation evolution and progress and the elimination of tables in the copper mills of the Phelps Dodge Corporation the articles by Cramer and MacDonald that appeared in the Oct. 27, 1928, issue of *Engineering and Mining Journal* are recommended. Perhaps the most surprising event of 1928 was the application of flotation to the Lake Superior native copper amygdaloid ores. Laboratory investigation by the U. S. Bureau of Mines with the Fahrenwald machine indicated that with a feed even as coarse as 14 mesh an additional recovery of 2 to 4 lb. of copper per ton was possible and a final tailing as low as 2 lb. of copper per ton, or 0.1 per cent. Flotation treatment costs no more than present jig and table methods, and, as much richer concentrates will be produced, a saving in smelting costs will be obtained. A rough estimate is that the additional annual profit to the mills of that district will total $1,500,000. Many of the mills are installing experimental flotation units, and plans are under way to re-treat old dumps. Commercial recovery of fine phosphate from present waste tailing in the South is practically assured, and the same is true of fine fluorspar. Encouraging results are being obtained in the flotation of bauxite from silica by the use of sodium sulphide, but it is not possible so far to separate the bauxite from iron oxide. Rhodochrosite has been floated experimentally from quartz by the use of sodium oleate.

Selective flotation remains in the limelight, as it has a marked economic effect on the mining industry. In the treatment of copper-bearing materials it has helped operators to make money in the face of low prices for the metal, and in the winning of lead and zinc it has brought more metal on the market and checked the rise in prices of these two metals. Prospects are for still further increases in production during the next few years at least. Custom mills continue as a stimulus for mining complex lead-zinc ores, and a field, which has not been filled as yet, exists for such mills in all districts where these ores occur in quantity. During the last seven years, omitting the Tri-State district, the production of lead flotation concentrates in the United States has increased four and one-half fold, and that of zinc thirteen fold. Jigs and tables are still used in treating lead-silver ores in the Coeur d'Alene district, but flotation has been adopted for lead-zinc ores. Tables are also used in all the lead mills of Southeast Missouri, but a proposed trial of all-flotation is receiving serious consideration. The conservative Tri-State district still retains jigs and tables for lead-zinc ores, but prediction is made that these may be replaced by flotation in spite of the handicap of fine grinding the hard chert gangue. In Wisconsin flotation has replaced the last roasting and magnetic plant for separating lead, zinc, and iron sulphides. Copper and zinc sulphides are selectively floated, although the separation is not as easy as in treating lead and zinc sulphides. The Anaconda copper mill has been remodeled, and the complex system of jigs, tables and flotation has been amazingly reduced in the treatment of freshly ground ore, which is treated in a single stage by flotation machines making finished concentrates, middlings that are returned to the head of the machines, and a tailing, sent to waste.

For the flotation of oxidized lead-silver ores, the Chief Consolidated mill, in Utah, has developed a process which avoids sulphidizing. The reagents are 3 lb. of sodium silicate, 0.6 lb. Aërofloat, and 5 lb. ethyl xanthate per ton of ore. Close control of hydrogen-ion concentration is essential, sulphuric acid being added to maintain the necessary acidity. Flotation of Katanga copper ores in a commercial way by the use of palm oil is an accomplished fact. F. M. Bird, in the April 21, 1928, issue of *Engineering and Mining Journal* has shown that in sulphidizing oxidized ores the grinding should be done in a pebble mill, as fine abraded iron in a ball mill rapidly oxidizes and forms deleterious coatings on the ore particles. In Australia this difficulty is overcome by grinding in a reducing atmosphere of producer gas.

Great credit is due Prof. A. M. Gaudin and his associates at Salt Lake City for providing a better understanding of flotation theory, including the flotation properties of pure minerals of all types and the nature and action of individual reagents. The point has been reached where, knowing the organic structure and chemical and physical properties of a reagent, it is possible to predict in a general way the action of the reagent in flotation. Adsorption of various gases may have various effects in flotation, and the use of gases other than air is a possibility. Differential flotation is governed to a large extent by surface coatings, and flotation in general involves chemical action.

T. M. Varley's annual compilation shows continued simplification in the number of reagents used and general increase in tonnage of ores treated by flotation. Alkaline pulps are the rule. Sulphur dioxide and bisulphites are receiving attention as pyrite depressers. Sodium Aërofloat, a new reagent made from ethyl alcohol, phosphorous pentasulphide, and sodium hydrate, has collecting properties only, but has less attraction for iron than xanthate in copper-iron separations. Raconite is a new xanthate made from caustic soda, carbon bisulphide, and an alcohol. Other modifications of xanthate have been developed.

Many mills are now equipped with jet type machines which give maximum simplicity and low cost. The Forrester and Southwestern-Welsh jet machines appear to be in the lead. Forrester units 60 ft. long are in use, and a Hunt jet type machine 100 ft. long is under consideration at Miami. A 35-ft. Hunt machine at the United Verde mill uses air at 1 to 1½ lb. pressure per square inch, cost $2,000, treats 300 tons in 24 hours, and uses 1 kw.-hr. per ton of ore. The MacIntosh cell, with its revolving cylindrical air blanket, has been improved mechanically. Mechanical agitation machines are still used where strong agitation is essential, as on oxidized ores and in some phases of differential flotation. The Texrope drive has been applied to Minerals Separation cells.

Flotation litigation in 1928 included the decision upholding the soluble frothing agent patent of Minerals Separation Company in the Magma case and the decision in favor of Anaconda upholding the xanthate patent. In this latter case the plaintiff, the Metals Recovery Company, filed an appeal.

Novelties and progress in general milling practice include a portable 50-ton grinding and flotation plant mounted on trucks for treating old dumps in Arizona; a 500-ton underground flotation plant under construction at Gilman, Colo.; complete equipment of mills in the Southwest for dust control; more general use of the microscope for regular examination of concentrates and tailings by operators, and selective coloring properties of oxide minerals as an aid in identification; appreciation of the value of oxyacetylene equipment for all sorts of welding and cutting work; employment of rubber where resistance to abrasion is desired and cutting effect is absent; reduction of power consumption by anti-friction bearings; and wide use of Texrope drives.

One disadvantage of the modern steel and concrete mill that was not foreseen is the difficulty of remodeling except at high cost. The new Errington 200-ton mill for differential flotation of copper-lead-zinc ore in the Sudbury district is now in operation. Descriptions of a number of mills in the Southwest by E. H. Robie appeared in *Engineering and Mining Journal* during 1928. The Miami mill is making a record on ore containing 0.85 per cent copper. Extraction is 90 per cent, concentrates assay 40 per cent copper and tailing 0.16 per cent, and cost is about 40c. per ton, but is expected to be reduced to 30c. Papers read at recent meetings of the American Institute of Mining and Metallurgical Engineers have been bound together and form a valuable book entitled "Flotation Practice."

In coal preparation, the feature of 1928 was the extension of the Rheolaveur process, which is also attracting the attention of ore-dressing engineers.

[2]Colorado School of Mines Quarterly, Vol. 23, No. 2, 1928.

Hydrometallurgy

By G. D. Van Arsdale

IMPORTANT extensions in the application of wet methods for the recovery of copper and zinc are being made. With the progress made in chemical knowledge and engineering application for these two metals; since the major basic principles are the same; and since the commercial need exists; there seems to be no valid reason why this proven knowledge and successful application cannot now be extended to include lead also, as the final major nonferrous metal recoverable by leaching. Present developments make this an accomplishment probable within the next few years. If lead leaching can be perfected along lines having the same general inherent advantages possessed, for example, by copper leaching, a complete hydrometallurgical system for complex ores can be definitely taken into consideration as an alternative standard method, with certainty of advantage and adoption under suitable commercial and metallurgical conditions.

This should not be taken to mean competition with or replacement of present methods. Neither copper leaching nor cyaniding, for example, is a competitor of smelting and concentration. Each process was developed, and is in use, for the solving of problems definitely belonging in its respective field. Competition arises only when attempts are made to extend unduly any method into other fields. Thus, for years, attempts were made without commercial success to extend flotation to include the treatment of mixed copper oxide-sulphide ores. It is now generally recognized that this cannot be done, because, generally speaking, the oxide copper minerals are not usually definite mineralogical entities, as are the sulphides, but are mixtures. A copper silicate particle, for example, in one minute microscopic field will vary from zero copper to high-grade material. No mechanical system can meet this condition. The treatment of mixed oxide-sulphide ores belongs definitely in the field of leaching. This applies to ores in which the copper sulphide is chalcocite or a similar readily soluble form. No method has so far been developed for the direct leaching of copper in the form of chalcopyrite.

In addition to references to new plants and improved practice in older ones some material of value may also be included in an article of this character as to general present tendencies and probable future results, with reference to general principles established by experience, although it should be recognized that such statements, being largely matters of personal opinion, may not hold later, in view of conditions not now apparent. Some of these principles may seem simple to the operating executive, but nevertheless they are of the greatest importance. In proportion as they are neglected or overlooked in starting a new enterprise, trouble will be likely to result.

Comparatively small changes in the physical character of an ore, the significance of which may be easily disregarded, or which inadequate sampling may have failed to reveal, may readily spell the difference between success and unfavorable results, or necessitate radical plant changes. Thus, in copper leaching by the percolation method, small variations (of the order of magnitude of 5 per cent or less) of original fines of amorphous character will seriously reduce extraction. The remedy for this is classification, and the separate treatment of slime and sand. Experiments in this department of metallurgy are being made in Arizona and in Chile. Obviously, commercial and financial results will be the deciding factors, but this application should result in increased over-all plant capacity, owing to decreased time for leaching and washing, and to higher extractions, because of the possibility of finer grinding and the removal of fines, which act as a coating on the larger particles. Thus, in one plant the best extraction is not reached until particle size is reduced to about 12 mesh or under. With clayey fines removed, a much nearer approach to this ideal condition is possible than at present. It is my opinion that with some ores the final step of all-fine grinding and agitation treatment of the entire charge will inevitably be taken. No insurmountable difficulties arise in fine grinding for copper leaching; and, as large-scale grinding cost is low, a comparatively small extraction increase will balance this. No one will advocate either modification unless definite commercial advantage can be shown; but, granted this condition, which can be demonstrated by tests, separate sand and slime treatment or an all-agitation plant are practicable; and, furthermore, for any given tonnage of ore, plant installation costs being roughly proportional to time of cycle, equipment for an all-agitation plant will cost least, separate treatment of sands and slimes will be intermediate, and an all-percolation plant will have the highest capital cost.

The underground leaching of broken ore and the heap leaching of dumps may be considered as established methods. Both are extremely slow and give incomplete extractions, but each has in its favor a low plant installation expense and usually low-cost copper. In many large mines, especially those using caving methods, after drawing ore large amounts of copper-bearing rock are left, from which recoveries at a profit may be made by leaching in place. However, in figuring probable costs, a ton of ore broken in place underground will require at least as much acid and iron or other leaching reagent as it would if raised to the surface, crushed fine, and placed in a vat. In many instances the acid needed will be greater, because the material will be decomposed and therefore have greater amounts of soluble constituents. Underground leaching is possible only on broken material. It is unreasonable to expect that pouring acid into a hole in the top of a hill, with a tunnel underneath and unbroken rock between, will accomplish much. To precipitate electrolytically the weak solutions from either of these two methods is of course not practicable. Detinned iron provides the bulk of the precipitant used in the Southwest.

A modern type of cementation plant is a satisfactory installation when compared with one of the scrap-iron launder plants of a few years ago; but, even under the best conditions, cementation is expensive as compared with electrolysis, and improvement in this respect is possible and probable. If sufficient reduction in cementation cost can be made, the method will be able to compete with electrolysis. In such event it is possible to foresee conditions under which an electrolytic plant will be installed only when it is necessary to provide ferric iron for the direct leaching of sulphide copper.

An interesting and important new application of heap leaching and cementation is that of the new plant of the Utah Copper Company, described in *Engineering and Mining Journal* of Oct. 6. Operation of the plant began in March. Natural surface water only is used, and the exit liquor from the cementation plant is sent to waste. The surface water percolating through various dumps, estimated to contain about 87,000,000 cu.yd., is collected and led to the precipitaing plant. The assay value of the various dumps varies from 0.3 per cent to 1 per cent copper, of which 50 per cent is chalcocite, 30 per cent is covellite, and 20 per cent chalcopyrite.

Heads to the plant averaged approximately 20 lb. copper per 1,000 gal. and tailing solution about 0.5 lb., equivalent to a recovery of about 97½ per cent. The average grade of precipitate made was 87 per cent. Inasmuch as the operation of the plant depends entirely on surface water, the quantity of solution treated and its velocity vary with the season of the year. The average flow is stated to be 1,000,000 gal. in 24 hours. On the basis of the figures

given, of about 20 lb. per 1,000 gal., this is equivalent to an average production of about ten tons of copper per day—a small production when compared to the amount of copper locked up in the various dumps. It would be of interest to determine if production could not be increased by changing the present method of discard of iron liquors by repumping these for redistribution over the dumps. Chalcocite and covellite are both readily soluble in iron solutions.

An operating force of sixteen men and a foreman is employed on each of three shifts daily during high-flow periods, this force being reduced to one foreman and three men working one shift during the period of low-flow of solution to the plant. Detinned iron scrap is used as the precipitant, the consumption of which is stated to be about 1¼ lb. per pound of copper produced.

The Phelps Dodge heap leaching plant at Bisbee continues in operation. Experimental heap leaching is being carried on by Inspiration. Microscopic studies of ores in connection with leaching experiments by the Pinto Valley Company, in Arizona, have been described by R. E. Head, of the U. S. Bureau of Mines.

One of the outstanding events of 1928 in copper leaching has been the starting of the leaching plant of Andes Copper at Potrerillos, of which the following description has been furnished by Mr. Frederick Laist.

The copper-leaching plant at Potrerillos is designed to treat 7,500 tons of ore per day. In general it follows the lines of the leaching plants at Ajo, Inspiration and Chuquicamata. Crushing is done by Symons disk crushers and the ore is leached by percolation in large concrete vats, which are charged and emptied as usual, a Wellman-Seaver-Morgan excavator being used. The tanks are lined with acid-proof brick laid in mastic. Copper is deposited from the solutions electrolytically; but, before being sent to the cell house, the solution is purified by treatment with just sufficient limestone to precipitate ferric iron and arsenic. Precipitate caused by the limestone is filtered from the neutral solution by means of a battery of Moore filters. The filter cake, although slimy, contains less than 0.5 per cent copper. The weight is small, and hence the copper lost thus is insignificant. It is understood that percolation troubles developed in starting the plant, owing to the presence of amorphous fines, the remedy for which is being worked out.

Bagdad Copper, at Hillside, Ariz., is building an experimental plant, consisting of a 50-ton flotation unit, roaster, agitation equipment, with provision for electrolytic precipitation of 1.500 lb. copper per day. A leaching unit to treat ten tons per day of carbonate ore is also being installed. Power is generated by two Diesels, of 360 and 75 hp., and the company is also installing a 180-hp. Diesel to be directly connected with a 2,000-amp. 50-volt, d-c. generator.

The new leaching plant of Mount Elliott, in the Cloncurry district of Australia, was described by H. S. Mackay in *Engineering and Mining Journal* of Jan. 14, 1928. It consists of five sections—crushing, roasting, leaching, electrolytic deposition, and power plant. The process used is as follows: An ore mixture of sulphide and oxide is made, which is then crushed to ¼ in. and roasted, to convert the copper into oxide and sulphide forms, and the iron to insoluble oxide. A double leach is used, first with water, the solution being purified to remove iron, and then electrolyzed. The acid solution produced is returned to the ore to dissolve the oxide copper. Conclusions reached from research on the sulphide dioxide iron oxidation method for making ferric iron and acid are described in Bureau of Mines Publication, Serial N. 2839.

Construction has been started on the new Nichols refinery at El Paso, which is expected to be in operation in the spring of 1930, with a capacity of about 100,000 tons of copper per year.

In an address before meetings of the A.I.M.E. and the Mining and Metallurgical Society, Raymond Brooks stated that the present production from the Congo-Rhodesian area is about 110,000 metric tons from Union Minière and 6,000 metric tons from Bwana M'Kubwa. Prediction was made that Union Minière would reach a production of 150,000 tons within two years, of which 30,000 tons would be from the leaching plant. It was stated that the probable production of copper from Rhodesian mines will equal that of the Congo within the next six years. It is estimated as follows: Bwana M'Kubwa, 12,000 tons; Roan Antelope, 45,000 tons; N'Kana, 45,000 tons; N'Changa, 45,000 tons; making the African production about 300,000 tons by 1935.

The Benguela Railway was completed to the border of the Belgian Congo in November, 1927. This will shorten the transportation distance for supplies and the product of the Union Minière by about 3,000 miles, bringing these mines about one month nearer the market. This, it is stated, will reduce the cost of delivered Union Minière copper by about 1½c. per pound.

In zinc hydrometallurgy, important events comprised the enlargement of production by the Anaconda, the start of operations of the Tainton process plant at Kellogg, Idaho, and the announcement of plans for the construction of a 50-ton Tainton process plant at East St. Louis by the Evans-Wallower Company.

The following notes in regard to Anaconda are furnished by Mr. Frederick Laist: The new plant at Anaconda is exactly 50 per cent as large as the Great Falls plant. The Anaconda plant contains four units, whereas the Great Falls plant contains eight. These units are of the same size and consume about 5,000 kw. of electric power each. Thus the new Anaconda plant uses about 22,000 kw. of power for electrolysis, exclusive of power used for equipment such as compressors, Dorr thickeners, and vacuum pumps, which amounts to about 5 per cent more.

The Anaconda plant started in January, 1928, and was in full operation by the end of February. It produces about 10,000,000 lb. of zinc cathodes monthly. The process used at Anaconda is the same as the one used at Great Falls, described by Elton, Caples, Frick, and Laist in the transactions of the A.I.M.E. several years ago. Practically no changes of importance have been made since that article was published. U. C. Tainton supplies in *Engineering and Mining Journal* of Dec. 1, 1928, data concerning the new Kellogg plant.

Feed to the plant is about 44 per cent zinc, 6 per cent lead, 5 per cent silica, and 11 per cent iron. The solubility of zinc after roasting as determined in a 2 per cent acid solution is about 87 per cent. Magnetic separators take out about 40 per cent of calcine, by weight. Extraction of zinc in the leach, about 91 per cent, is expected to be increased. The residues carry from 8 to 10 per cent zinc, about 13 per cent lead, 23 per cent iron, and 9.5 oz. silver.

In the electrolytic division the cell voltages measured at the switchboard range from 3.2 to 3.4 volts per cell. Current efficiency is about 90 per cent, making an average power consumption of 1.36 kw.-hr. per pound of cathode zinc produced. The temperature in the cells is kept between 35 and 40 deg. C. The plant was erected to treat the zinc bearing ores of the Coeur d'Alene district, which tend to form unusually large amounts of zinc ferrite in the roast and considerable amounts of gelatinous silica in leaching. These ores also contain cobalt. The Sullivan plant was therefor designed to use the Tainton high-acid, high-current-density process. The return electrolyte used for leaching carries about 28 to 30 per cent free acid, and the electrolysis is carried out at a current density of 100 amperes per square foot, both of these figures being about three times as great as the corresponding figures in ordinary electrolytic zinc practice.

Five roasters, 25 ft. outside diameter, with seven roasting hearths, and one drying hearth, of standard Wedge construction with some special features, are used. For full details of operation, reference is made to the article mentioned in the foregoing. A few details, however, are worthy of special mention. A new cathode construction greatly superior to the older type; the production at the anode of lead-free manganese dioxide suitable for sale; reduced labor from an improved cathode lifting

system; and the production of a high-grade metal, averaging consistently above 99.99 per cent, which has required the development of special analytic methods to show any impurity. An improved method of forming a protective layer on the surface of the solutions has been developed to an extent that acid spray in the cell house has been almost eliminated. As the author states, this means a good deal in regard to the efficiency of the operators and also in the maintenance of contacts and cell room equipment generally. We were singularly fortunate, states Mr. Tainton, in that the starting up of the plant did not develop nearly as many difficulties as one is entitled normally to expect . . . due chiefly to the liberal policy of the parent companies that the best was none too good.

Announcement is made that construction is started for the 50-ton zinc leaching and electrolytic plant of the Evans-Wallower Company, at East St. Louis, in which the Tainton process will be used, for which the company has exclusive license for Missouri, Kansas, Oklahoma, and Arkansas. Raw material will be flotation concentrates. Byproducts will be lead, cadmium, manganese dioxide, and sulphur dioxide. The following are the estimated construction costs:

	Total	Per Cent of Total
Electrical equipment	$104,000	13.4
Tanks and machinery	241,000	31.1
Metals	112,000	14.4
Steel	75,000	9.6
Building material	125,000	16.1
Labor	105,000	13.5
Freight and miscellaneous	13,000	1.9
	$775,000	100.0

Other costs are estimated as follows: Incidental, $25,000; rent of roasting plant, $6,000; engineering, $40,000; power lines, $40,000; insurance, $17,000; interest, $50,000; company overhead, $12,000; consulting and traveling expenses, $23,000; cost of land, $12,000; total, $225,000; making a total of about $1,000,000, or $20,000 per ton of metal produced per day.

R. E. Phelan has described the results of research for treatment of the Flin Flon ores. In pilot-plant tests, following test-plant scale work in Denver, difficulties developed which required the working out of methods to meet them. A 3,000-ton mill is being planned, with the flow sheet as now developed. The Ashcroft process, tested in a unit with a capacity of five tons per day, is to be used at Avonmouth, in Great Britain. The ten-ton trial unit of the Coley process at Birmingham, England, is still engaged in tests. Results from the Elmore Chemical method of treatment owned by the Chemical & Metallurgical Corporation should be available during 1929 from the plant erected in England. Recent developments in ammonia leaching for zinc ores are discussed by Lawrence in a booklet issued by the School of Mines and Metallurgy of Rolla, Mo.

A record of new developments in cyanidation during 1928 is confined almost exclusively to a list of new plants that have been built. Several of these, including the Ariston Gold plant and the Achotla unit of American Metals, in Mexico, were referred to in the Annual Review for 1927, as was also the operation of the test mill for cyaniding base flotation tailings at Flin Flon. This experimental work has not been completed.

Two new plants went into operation in Canada during 1928—the 350-ton Coniaurum mill at Timmins, Ont., and the 100-ton Siscoe mill at Amos, Que. The former has been in operation for several months and the Siscoe was expected to begin early in December. Both plants follow the conventional Canadian practice—grinding in cyanide solution in two stages, followed by primary thickening, agitation, and one stage of decantation preceding filtration, in continuous filters. The Merrill-Crowe precipitation process is used for precipitation. As regards Mexico, the operation of the Achotla unit of American Metals was described in considerable detail by E. R. Richards in *Engineering and Mining Journal* of Sept. 1 and Sept. 8, 1928.

Clarified pregnant solution is precipitated easily and rapidly by the Merrill-Crowe process. Precipitate contains from 65 per cent to as high as 85 per cent gold and silver, averaging about 70 per cent. Salt is the most expensive reagent used, costing about $34.50 per ton f.o.b. the mill. Under normal operations the consumption is 6 per cent, or 2.07 per ton of ore. Cyanide is next in importance in cost, and with normal heads and furnace operation consumption is 1½ to 1¾ lb. per ton of ore. Consumption of lime is around 50 to 60 lb. per ton of ore, and the amount of zinc dust required is close to the theoretical quantity. Power consumption averages about 21 kw.-hr. per ton of ore treated. Under steady operations, gold extraction is from 92 to 96 per cent and silver extraction from 82 to 88 per cent.

The 75-ton mill of the Chontalpany Anexas at Zacualpan, State of Mexico, was completed during 1928 and has proved efficient in operation. The equipment is substantially the same as that described in the foregoing as standard Canadian practice, with the exception that another stage of decantation is added preceding filtration. Interesting work is being done in the use of the Caron-Clevinger reducing roast at the old El Favor mine by the Tigre Leasing Company, and a practical solution seems to have been reached on what has been one of the most difficult precious-metal treatment problems.

Except for the plants mentioned in the preceding paragraph, new work in cyanidation in Mexico during 1928 has been confined to various schemes to treat the accumulated patio tailings at Zacatecas, Pachuca, and Guanajuato. A measure of success has attended these efforts at Guanajuato under the technical supervision of the United Eastern Company, but details of operation are not available. In Venezuela, two new plants are contemplated, one for Bolivar, Venezuela, for 100 tons' capacity, and another for the Consolidated Gold Field of Venezuela, with a capacity of 500 tons. The treatment will probably be similar to that described in connection with Canadian ores.

One of the outstanding developments of 1928 was the new plant to be built for Wiluna Gold at Wiluna, Western Australia. A flotation concentrator is to be built at this property, with a capacity of about 40,000 tons of ore monthly. The concentrator is expected to produce about 150 tons per day of concentrate, which is to be roasted for the recovery of arsenic. The calcine will be treated by cyanidation to recover the gold. Precipitation of gold will be effected by the use of the Merrill-Crowe process.

Another interesting development of 1928 was the attempt to treat accumulated leached concentrate dumps at the property of the Oriental Consolidated, in Korea. The procedure is to crush in stamps and amalgamate, following which the tailing is concentrated on tables and vanners, producing a product that is leached in open tanks for upward of three weeks. The accumulated residue from this leaching operation, in various stages of oxidation—from the pure red portions which have been oxidizing for more than 30 years to the comparatively fresh portions recently added to the dump—is now being treated. A ten-ton experimental unit has been in operation for several months, and the results indicate that a combination of re-concentration, re-grinding, and cyanidation will yield a fair profit from the re-treatment of this material. As might be expected, the cyanide consumption is fairly high.

In Africa the 1,000-ton mill of Ariston Gold, mentioned in the last Annual Review, has begun operations. The plant is equipped to use the Merrill-Crowe process, which employs vacuum leaves in place of the usual filter press. In Rhodesia a new mill is to be built at the recently developed Wanderer mine. The process and equipment to be used will be similar to those already referred to in connection with recent Canadian plants.

On the Rand no new plants were built during 1928, although several enlargements have been completed, particularly at the Sub Nigel and West Rand Consolidated, at both of which advantage has been taken of the remodeling and enlargement program to moderize the equipment by installing continuous vacuum filters in place of decantation and the Merrill-Crowe process in place of zinc shavings.

Mining Geology

By J. Volney Lewis and Joseph M. Wanenmacher

AMONG the outstanding reasons demanding the new (third) edition of his "Mineral Deposits," Professor Lindgren enumerates new discoveries, new viewpoints obtained from the re-examination of old deposits, and the rapid progress of physics and chemistry, particularly as relating to the composition of the earth and the laws governing magmas. These modern trends of economic geology have found potent aids and adjuncts in the growing recognition and adaptation of geophysical methods; in more intensive microscopic research in opaque ores, microfossils, and heavy minerals; and in the wider use of aërial photography in mapping. In this connection mention should be made of Ambronn's "Elements of Geophysics," now translated into English by Dr. Margaret C. Cobb, and "The Laboratory Investigation of Ores," a symposium edited by Ernest E. Fairbanks. Students of ore deposits have stressed the need for fundamental physical and chemical data to be obtained only through research. Lindgren[1] especially has shown that individual effort at this stage can produce but limited results. Many subjects of inquiry demand the co-operation of the chemist, the physicist, and the geologist, and the funds now available for such work are inadequate.

A striking feature in the development of theories of ore genesis during the year has been the marked emphasis by many writers on the importance of fracturing and brecciation of the country rocks, rather than their composition. The dominance of fissuring in the formation of replacement deposits in the Guanajuato district, Mexico, has been pointed out by Wandke and Martinez[2]. Bonanza deposits are found in igneous, metamorphic, and sedimentary rocks. Unsupported blocks of country rock are interpreted as remnants of incomplete replacement. Locke[3] has also stressed the major importance of openings in the formation of ore deposits in general. Subsidence that is the result of solution by the ore-bearing fluids is considered a prime cause of fracturing. Grimes[4] also concludes that fissuring is paramount and the composition of the wall rock only a minor factor. He further finds evidence that the emanations from a consolidating magma change progressively from dilute acid-gaseous to concentrated liquid-alkaline, and that the primary zoning of the sulphide ores follows the order of their solubility in alkaline solutions.

Cooke and James[5] have studied the sulphide ores of the Rouyn district, Quebec, which are generally found in acid volcanic flows and tuffs. The rhyolites are the most brittle rocks of the region; hence they have been broken into breccias that were easily invaded and replaced. Walker[6] has reviewed the ore deposits in volcanic pipes, where breccias have afforded conduits for rising solutions and have been in turn replaced by a wide range of minerals, including some commercial ores. In contrast with the foregoing, Whitman[7] has concluded, on the basis of experimental evidence, that diffusion plays a major rôle in replacement, since by this means deposits may be formed where channels of circulation are closed.

Dolomitization has accompanied the deposition of many ores in limestone, including most lead and zinc sulphides, some copper sulphides, and manganiferous siderite deposits. Hewett[8] finds that in most cases dolomitization has preceded the ore. He suggests that this change has probably accompanied the deposition of many ores in limestones where it has not yet been recognized. The most probable sources of the magnesium are thought to be magnesian limestones, through artesian circulation, and the intense alteration of igneous rocks by magmatic solutions. From a consideration of the physico-chemical factors involved, Ross[9] concludes that hydrothermal solutions can penetrate even capillary openings, but that magmas probably cannot be introduced into veins. Newhouse[10] has attempted to correlate the properties of the elements with the mineral succession in replacement deposits. The results are interesting and suggest the desirability of laboratory research in order to obtain more data.

Among copper ores, the native deposits at Corocoro, Bolivia, have been studied by Singewald[11], who concludes that, like those of Michigan, they have been formed through the reaction of rising sulphide solutions with the ferric oxide of the red rocks. Geier[12], on the other hand, notes the absence of zeolites at Corocoro and differentiates the deposits from the Lake Superior type. He ascribes their origin to the absorptive action of kaolinic materials on acid thermal solutions. The shrinkage of certain oxidized orebodies in limestone has caused subsidence at Bisbee, according to Wisser[13], and the effects in some places have reached the surface. Some of the displacements followed pre-existing faults and fractures, and it is noted that similar movements may result from solution caverns and from mining operations. Trischka[14] finds two types of silica replacing limestone in the Warren (Bisbee) district. One of these is associated with commercial ores and may be used as a guide.

The Katanga copper ores, Belgian Congo, are found in limestones, conglomerates, and schists of uncertain age, as described by Kroll[15]. The rocks were folded in late Carboniferous and faulted in Triassic time. Most of the deposits are found along the faults, especially in the fissured dolomite. The ores are oxidized at the surface, but sulphides are found at depth. As yet the origin is unknown.

The silver ores at Potosi, according to Lindgren and Creveling[16], were formed by aqueous solutions, which at 200 to 300 deg. C. deposited pyrite, quartz, and cassiterite, and later, at 100 to 150 deg. C., deposited silver minerals. The solutions came from the Pliocene (or later) magma which exuded from a volcanic vent at this locality. The veins are in part fissure fillings and in part replacements in shales, slates, and acid porphyry. Neither vertical nor horizontal zoning is apparent. The oxidized zone has been enriched. The silver mineralization at Beaverdell, B. C., has been described by McKinstry[17] as replacement deposits in quartz diorite formed at depths of 2,000 to 3,000 ft. by emanations from quartz monzonite. Three generations of minerals are recognized and are ascribed to regeneration of the solutions. No zonal arrangement occurs and supergene action is limited.

The remarkable zinc ores at Franklin, N. J., are still the source of wide divergence of opinion. Fitch[18] ascribes both the zinc deposits and the accompanying magnetites to the magma of the Byram granite-gneiss. A non-volatile, iron-rich fraction formed one differentiate; a volatile fraction, rich in mineralizers, carried zinc oxides, some manganese, silica, and a little iron. This theory is based on a laboratory study of specimens and a library study

[1] *Economic Geology*, 1928, pp. 591-611.
[2] *Economic Geology*, 1928, pp. 1-44.
[3] *Economic Geology*, 1928, pp. 93-98.
[4] *Mining and Metallurgy*, 1928, pp. 532-546.
[5] *Canadian Mining Journal*, 1928, pp. 670-674; 696-698.
[6] *Engineering and Mining Journal*, Dec. 8, 15, 22, 1928.
[7] *Economic Geology*, 1928, pp. 473-488.
[8] *Economic Geology*, 1928, pp. 821-863.
[9] *Economic Geology*, 1928, pp. 864-886.
[10] *Economic Geology*, 1928, pp. 647-659.
[11] *Economic Geology*, 1928, pp. 55-61.
[12] *Neues Jahrb. Min.*, p. 58, Abt. A, 1927, pp. 1-42.
[13] *Economic Geology*, 1927, pp. 761-790.
[14] *Engineering and Mining Journal*, June 30, 1928, pp. 1045-1050.
[15] *Mining Journal*, 1928, p. 485.
[16] *Economic Geology*, 1928, pp. 233-262.
[17] *Economic Geology*, 1928, pp. 434-441.
[18] *Mining Magazine*, 1928, pp. 82-84.

of the geology. Palache[19], after long and intensive study of the minerals, in the laboratory and in the mines, has concluded that the deposits have been formed by the metamorphism of an ancient zinc gossan.

Two, and possibly three, iron-bearing formations occur in the Cuyuna range, which Zapffe[20] interprets as a portion of the north limb of a synclinorium. The titaniferous iron ores of New York, Ontario, and Quebec are not magmatic segregations, as has been supposed, but, in the opinion of Osborne[21], they are magmatic injections into anorthosites, gabbros, and related rocks. Some of the orebodies are concordant with the structure of the inclosing rock, but others are discordant. The large iron reserves of South Africa, as described by Wagner[22], are surpassed only by those of the United States, France, India, and Brazil. The bedded deposits are the most important, but secondarily enriched sedimentary deposits of the Lake Superior type, contact-metamorphic, replacement, and segregation types are also present. Coal, manganese, and other ferro-alloy metals provide the raw materials for a steel industry. In contrast, Brock[23] concludes that China is deficient in the minerals for industrial development, excepting coal.

That the nickel silicates of Webster, N. C., were formed by supergene replacement of the magnesium of vermiculites, and to a lesser extent other minerals, is the conclusion of Ross, Shannon, and Gonyer[24]. The vermiculite veins are products of hydrothermal action. The source of the nickel is the olivine of the dunite in which the veins occur. Heldring[25] describes the tin deposits of Southwest Africa as cassiterite-bearing pegmatites and quartz veins. The former carry muscovite and locally tourmaline, biotite, and other minerals, the assemblage depending on the distance from the parent granite. These deposits of high-temperature gaseous and aqueous solutions have given rise to valuable eluvial concentrations.

Commercial bauxite deposits of British Guiana are massive lenses overlain by sands and underlain by clay, and Emory[26] suggests that they may be chemical precipitates. Woolnough[27] connects deposits of bauxite and white clay with profound weathering in the later stages of peneplanation. Bauxite is precipitated and accumulated by ground waters in such regions under a climate of seasonal rainfall. On transportation the white clays accumulate in beds at the outer fringes of alluvial fans. The supposed origin of corundum by the desilication of pegmatites in reaction with ultra-basic rocks is questioned by Larsen[28]. He also discards the theory of crystallization from the basic magma and advances evidence of the origin of corundum through high-temperature hydrothermal action. Extensive phosphate beds of Idaho are preserved mainly in down-folded and down-faulted areas. Mansfield[29] believes that the abundant oolites were formed on the sea bottom from phosphatic solutions or colloids by means of biochemical and physical agencies.

Russell[30] and Meinzer[31] independently arrived at the conclusion that artesian aquifers are compressible and that they subside when water is extracted. Artesian pressure is in large part attributed to the weight of overlying rocks. Elasticity must be taken into account in estimating the supplies of water obtainable. The same principles should apply to bodies of oil and gas.

[19]Mining and Metallurgical Society of America, New York meeting, Dec., 1928.
[20]*Economic Geology*, 1928, pp. 612-647.
[21]*Economic Geology*, 1928, pp. 724-761; 895-922.
[22]Geological Survey of South Africa, Memoir 26.
[23]*Economic Geology*, 1928, pp. 209-213.
[24]*Economic Geology*, 1928, pp. 528-552.
[25]*Mining Journal*, 1928, pp. 371, 386, 410, 432, 460.
[26]*Mining and Metallurgy*, 1928, pp. 8-11.
[27]*Economic Geology*, 1928, pp. 687-894.
[28]*Economic Geology*, 1928, pp. 398-428.
[29]*Mining and Metallurgy*, 1928, pp. 19-20.
[30]*Economic Geology*, 1928, pp. 119-132.
[31]*Economic Geology*, 1928, pp. 263-291.

Pyrometallurgy—
Copper and Lead

By E. H. Robie
Associate Editor

THE year 1928 was a busy one for copper smelters; especially so in the last few months, when smelter facilities were taxed to the utmost at many plants to turn out enough blister copper for the greatly augmented demands of industry. Fortunately, it has been possible to provide additional reverberatories in short order, for the increased duty of the modern furnace of this type has resulted, in recent years, in a lessening of the number in use, thereby leaving foundations on which new brickwork could be erected quickly. Converter capacity was adequate for the treatment of a considerable additional tonnage of matte; and roasters, thanks to the improved grade of concentrates supplied by the selective-flotation plants, were immediately available for the increased production. Perhaps it is the refining capacity of the country that is now being taxed the heaviest, and only one important new plant of this kind is now under construction in America, that of the Nichols Copper Company at El Paso, Tex.

Depression of the pyrite in flotation concentration has resulted in less roasting being required to secure matte of the grade desired in reverberatory smelting, so that the multiple-hearth roasters in general use function, at many plants, only as mixers and preheaters. In a few instances, in fact, they have been dispensed with entirely, the raw, damp concentrate being fed direct to the smelting furnace. This, of course, cuts down its capacity and results in charging difficulties, although eliminating all expense in the added treatment formerly required, and less trouble from magnetite choking up the furnace.

Most smelters, however, still have excess sulphur in the ore or concentrate received, a notable example being the Copper Queen reduction works at Douglas. The installation there of enlarged, superimposed roasters over the reverberatories has attracted a great deal of attention. Early difficulties were experienced in the distribution of the material, snowballing of the charge in the roaster hoppers, and in obtaining a proper distribution of the gas to the Cottrells, but these troubles were gradually corrected and recent performance has been in line with preconstruction estimates. The practice at that plant is unique in many respects and a full description is looked forward to with considerable interest.

The Noranda smelter, latest of the copper producers, has now completed its first year of work, with the success of the heat recuperator still to be demonstrated. Perhaps the chief difficulty has been the clogging of the flues by coal ash. The second reverberatory at this plant was installed with waste-heat boilers, as is the common practice, and it is probable that this arrangement is the most economical unless electrical power is extremely cheap. Former experience with recuperators has been with producer gas fuel, thus eliminating the difficulties due to dust deposition. On furnaces fired with fuel oil such trouble would also be small. Fuel oil is commonly used where it is cheaper, on a heat-unit basis, than powdered coal, which it is in the Southwest generally. The Noranda smelter has the tallest reinforced concrete stack in America, 422 ft. high, a description of which was published during the year.

At Panda, in the Belgian Congo, coarse concentrates from oxidized ore go to the blast furnaces at Lubumbashi, but the fine concentrates are now treated in the new reverberatory plant at Panda.

The reverberatories there are fired with powdered coal, the charge consisting of concentrates and flux, with some coal added for reduction. The black copper produced is refined in a second reverberatory. Katanga is gradually increasing its output, other developments being a new electrolytic refinery at Oolen, Belgium, and a new leaching and electrolytic plant of 36,000 tons' annual capacity approaching completion at Panda.

New construction is also going on at Copper Cliff, Ontario, where the International Nickel Company is making a large addition to its smelter to take care of the ore from its Frood mine. Heretofore, this has been largely a blast-furnace plant, with perhaps the only remaining example of open-heap roasting, but the new equipment is of the usual concentration-roasting-reverberatory type. The very latest ideas are being embodied in its construction, and when completed, a year or so hence, it should be of great interest to copper metallurgists.

A trend is in evidence toward the conversion of lower-grade mattes in larger units. When the matte supply is ample, the 13x30-ft. Peirce-Smith converter is in general use. On a 35 per cent matte, this converter has a blister output capacity of nearly 100 tons per day, besides smelting a large tonnage of secondaries and siliceous ores. The lower-grade mattes, of course, decrease reverberatory losses, increase the smelting rate, and decrease the troubles due to magnetite. Incidentally, F. S. Wartman and G. L. Oldright, of the U. S. Bureau of Mines, published an interesting bulletin at the end of the year on magnetite and ferrous sulphide reactions.

Low-grade siliceous lead ores can be handled economically in a copper converter, the lead being fumed and collected by Cottrell equipment. A 50 per cent lead fume can be precipitated, and sent to a lead smelter.

Copper roaster and converter gases are almost universally treated by Cottrell fume precipitators, usually of the plate type, but reverberatory gases usually go direct to the stack, with perhaps a settling chamber intervening. Treatment of leady converter fume is the only real problem now for Cottrell operators. With sufficient treater and power capacity, and careful attention to temperature control and gas distribution, a good clearance of the lead fume can be made without any water or acid conditioning.

The Carson litigation concerning the side-feeding of reverberatories continues, with the advantage all with Carson. Anaconda lost its case before the Court of Appeals on May 28, and the U. S. Supreme Court denied a review of the case on Oct. 22. On Nov. 19 the federal district court at Tucson decided that Phelps Dodge and Calumet & Arizona had infringed the Carson patent. The American Smelting & Refining Company has submitted an accounting covering all its plants at which infringement was alleged. Present reverberatory practice is divided, some plants, by center feeding with satisfactory metallurgical results, escaping the Carson royalty payment, while others continue their former practice.

The Consolidated plant, at Trail, B. C., has, I believe, continued its experimental work with the electric furnace, and the Evergreen Mines Company, at Apex, Colo., has carried on some successful tests with the electric smelting and conversion of copper ores in one unit, with a possibility of adapting the process to small mines where power is cheap and transportation is expensive.

In Michigan, the Calumet & Hecla company has been modernizing and extending its native-copper smelting plant, which work is expected to be completed in a few months. Michigan copper is practically the only primary copper in North America that is not electrolytically refined.

Developments in flotation continue to exert an important effect on the pyrometallurgy of lead. The fine grinding of complex ores, with the depression of both zinc and iron in the subsequent flotation process, has resulted in the production of high-grade lead concentrates low in active slag-forming material, but relatively high in zinc, which class of material now constitutes the bulk of smelter tonnage. As a result, though bullion production at the various plants has increased, many preroasters and blast furnaces have been shut down.

Recent experience has been that the successful treatment of flotation slime carrying appreciable amounts of zinc generally involves double sintering. Careful preparation of the charge as regards character of the diluent, mixing, and the fine-crushing of the "first over" are essential for the production of a satisfactory final sinter. The expense involved in this procedure is compensated for by the freedom from blast furnace and settler troubles formerly caused by zinc mush. Economy of iron flux is also gained, together with cleaner slags. In general, it may be said that the sintering operation has become the most important branch of lead smelting. Sintering machines 63 in. wide are now in use, burning coke breeze for ignition and producing up to 350 tons per day of final sinter.

Thorough double roasting generally results in there being no matte fall in the blast furnace, although with strong reduction, and arsenic on the charge, a small amount of copper-iron speiss may be formed. Most of the copper in the lead circuit is driven into the furnace dross, which is then smelted with scrap iron and fluxes in small reverberatories equipped with unit coal pulverizers. This treatment produces lead bullion and a mixed matte and speiss assaying about 50 per cent copper and 10 per cent lead. The best disposal of this seems to be to ship it to a copper plant, where it is charged to a converter.

Blast-furnace operation changes but little. Control of air by flow meters is worth noting. Better control over reduction is being secured at the Murray plant by balancing the air and coke supply so as to maintain a uniform concentration of carbon monoxide in the furnace shaft.

At East Helena, the Anaconda Copper company is treating 300 tons daily of molten lead furnace slag high in zinc in a fuming plant. Satisfactory recoveries, as baghouse fume assaying 66 per cent zinc and 5 per cent lead, are secured by blowing powdered coal through the tuyères of a blast furnace filled with the molten slag. The precipitated zinc fume is shipped to the company's electrolytic zinc plants. The Consolidated works at Trail, B. C., is reported to have built a slag-fuming plant of smaller capacity.

The practice at most lead smelters is to send the blast-furnace gases to a baghouse and roaster gases to a Cottrell plant. The most economical treatment for sinter plant gases, however, is open to debate. This fume is difficult to condition and the condensed acid is corrosive to the parts of a Cottrell treater. Trail has largely solved the problem by developing a treater the housing of which is contructed of cedar wood. Sinter gases are also corrosive to woolen bags, which have only a very limited life in this service. However, better bags are being secured, temperature control is being improved, and filtration is conducted in a more intensive manner, with better equipment, so that bag filtration progress is keeping pace with Cottrell developments and the two methods are about on a par for sinter gases.

In refining, several improvements have been made in plants operating the Parkes process. The capacity of softeners has been increased by speeding up the elimination of antimony and arsenic. Liquation of crust from the desilverizing kettles is practiced at Kellogg, where it is reported that ten tons of crust per day is melted in cast-iron pots. The products are liquated lead, which goes back to the desilverizing kettle, and a high-grade zinc-silver alloy subsequently treated in retorts. Several refineries have adopted the Betterton dezinking process whereby the zinc is removed by chlorine gas in the form of zinc chloride. This can be disposed of as a by-product, or can be electrolyzed for recovery of the zinc and the regeneration of the chlorine.

Satisfactory progress has been made with the development of the Harris process at Perth Amboy, N. J. The mechanical difficulties involved in the handling of caustic solutions and salts are now well in hand. As to the treatment of salts for the recovery of by-product metals, tin is being recovered as electrolytic tin, antimony as sodium antimonate or metallic antimony, and arsenic as calcium arsenate. Where the Harris process is used for dezinking,

the zinc is recovered as oxide. Based on the experience gained at Perth Amboy, an improved plant of 12,000 tons' monthly capacity is approaching completion at Monterey, Mexico. Here, it is expected, the process will realize its full possibilities. While speaking of Perth Amboy, it is worthy of note that a new Betts process plant for the electrolytic refining of lead has been under construction during the last year, the only others being at East Chicago, Omaha, and Trail.

No new lead-smelting plants were placed in operation during 1928. At Mount Isa, Queensland, plans have been made to erect a plant with an eventual capacity of 58,000 tons of lead annually. The first unit is expected to be in operation by next fall. Installation of some form of lead reduction works in Ontario also seems imminent, for treating ores from recently developed mines.

During 1928 the U. S. Bureau of Mines began an investigation of lead blast-furnace practice, which is centering at its Salt Lake station. Preliminary results will possibly be made public in 1929. The Bureau has also studied the treatment of oxidized lead ores containing molybdenum, for which it recommends chloride or oxide volatilization, the former when silver recovery is desired.

Pyrometallurgy—Zinc

By W. R. Ingalls

THE program for plant modernization in America that was formulated in 1927 under the constraint of increasing delivery of flotation concentrate was vigorously carried out in 1928, which became therefore a year of demolition and reconstruction. The program has comprised improved means for drying, the substitution of roasting furnaces of the Ingalls-McDougall type for the old Hegelers, sintering by Dwight-Lloyd machines, and the introduction of Cottrells and other means for dust collecting. Only the distilling furnaces and practice remain unaltered, but the use of sintered ore has had a beneficial effect upon them.

Such a program has been carried out in varying degrees at Bartlesville, Donora, Rose Lake, and Langeloth, the revision at the last plant being perhaps the most elaborate. Other plants that are now being improved are La Salle and Rosita (Mexico). These modernizations have involved expenditures averaging about a million dollars per plant.

In Europe, where the new metallurgical problems have been similar, although perhaps less acute, there have also been programs for improvement, the most important of which have been the modernization of Uethemann by Giesche in Polish Silesia and the entire reconstruction of Flone by Vieille Montagne in Belgium. Uethemann has been reframed, up to the distilling department, on American lines; but in general European conditions do not sanction the extremely large roasting furnaces that we have been building here. The Langeloth furnaces, with their twelve hearths of 20 ft. diameter, are probably the largest mechanical blende-roasting furnace operating in the zinc industry.

In principle, however, American and European thoughts are quite the same. Both contemplate preroasting followed by sintering. America adopts the straight-line Dwight-Lloyd, whereas Europe divides between the straight-line and annular. Its straight-line machines, however, are designed with improved seals between pallets and wind box, which is a meritorious improvement that will no doubt be followed here in future constructions. Europe and America employ both the Rigg and Baelen processes. For dust collection Cottrells are in general use, but Langeloth is dispensing with the Cottrell, temporarily at least, and relying upon the new Whitmore-Sirocco form of cyclone, which is a distinct novelty in blende-roasting practice.

Distilling furnaces remain unchanged. New Jersey Zinc finally abandoned the Convers & Desaulles and substituted the Neureuther-Siemens, but with only 240 retorts instead of 800 as at Depue, Peru, and Rose Lake. In Europe also the counter-current recuperative furnaces are passing out of use. Flone is being rebuilt with Dor furnaces, which many Belgian metallurgists consider to be the best, but in other plants there has been a noteworthy extension in the use of the Tanier furnace. The Giesche metallurgists, however, adopted the Welzel as their standard.

An important development of 1928 was the increased employment of the Waelz process for burning zinc out of low-grade ores and residues. This process is now regarded as an established and successful feature of the pyrometallurgy of zinc. In America, however, the only application is at Donora. The Waelz fume may go either to distillation, to lithopone manufacture, or to electrolytic beneficiation. If necessary to distil this fume the Roitzheim-Remy furnace may be used. A plant fully equipped with these furnaces is operated regularly at Berlin, galvanizers' ashes and skimmings being the material distilled. For ore distilling, however, the Roitzheim-Remy furnace has not proved itself. Such an application was tried earnestly at Bensberg. During 1928, a Roitzheim-Remy furnace was erected and put in operation at Avonmouth.

In the subject of zinc distilling in vertical retorts, continuously operated, the overshadowing event is the development of the revolutionary Singmaster, Breyer & Bunce furnace and process by New Jersey Zinc at Palmerton. After prolonged trial of what was already a large furnace, a regular commercial unit has been built there and is almost ready to be placed in operation. Columnar retorts of great height and relatively large diameter and the use of a charge in the form of briquettes, or eggettes, are the elemental features. The Ashcroft-Lacell and Coley processes continued to be the subject of pilot-plant experimentation at Avonmouth and Birmingham respectively, but neither of them appears yet to be ready for commercialization.

Reverting to the subject of standard metallurgy, Overpelt introduced the process of making macaroni (metaphorically) out of the roasted ore as a preliminary to sintering, the idea being to improve the suction through fine ore and avoid dust loss. Such a process of making up the ore was once tried experimentally in at least two works in this country as a preliminary to roasting, but was rejected as being too costly. In the sintering process itself we do not find any difficulty in getting an even and adequate suction through a bed of preroasted flotation concentrate, and the loss of fine dust is slight. The sintering department may have a seriously dusty atmosphere from causes exterior to the sintering machine, but this may be corrected by the proper housing of dust-raising motions and otherwise by sucking away dust eddies to a collector.

Improvements that are being made in the pyrometallurgy of zinc, referring now only to the modernization of existing plant, will have the effect of increasing the percentage of extraction by reducing the losses in dusting and in distilling, and at the same time they will reduce operating cost, especially in the desulphurizing part of the process. This will be accomplished at the expense of the charges, on account of the large capital outlay that is being incurred. We may visualize what a continuously operating retort, fed and discharged by gravity, may do for the industry, but we hardly venture to count upon that yet, although such a consummation is in sight.

United States Mining in 1928

By S. D. Strauss,
Editorial Staff

IN 1928, the downward trend of United States mine output that occurred in 1927 was checked. With prices for many mineral products in the closing months considerably higher than those prevailing throughout the rest of the year, the future may be faced with confidence. Estimates indicate that the combined value of metallic and non-metallic mineral production, fuels excepted, in 1928 was $2,500,000,000, compared with a total of $2,427,000,000 in 1927. The larger part, if not all, of the increase in the value of metallic minerals produced, from $1,217,000,000 to $1,260,000,000, may probably be attributed to the higher price and greater production of copper during 1928. Non-metallic production is estimated at $1,240,000,000, compared with $1,210,000,000 for the preceding year.

According to the data on which Fig. 1 is based—the monthly output of copper, lead, zinc, and silver in the United States as prepared by the American Bureau of Metal Statistics—1928 was the most active year from a productive standpoint that the non-ferrous metal mines have had since the records were started in 1925. As compared with a composite average of 100 for 1925, 1926, and 1927, the year just closed averaged 102.7. The next best year was 1926, with an average of 101.4, whereas 1925 had an average of only 98.5 and 1927 one of 100.1. Until the beginning of October, operations in 1928 had been about on a par with the composite for the other three years. The large expansion that took place among the copper mines in the last three months was the determining factor in the comparatively good record that was made.

Production data on the minor metals and non-metallics are not as readily available as for copper, lead, zinc, silver, and gold, but the indications are that in most cases 1928 was a satisfactory year, and that in the case of quicksilver, notably, it was a very good one. The high prices which have been consistently maintained by the Italian and Spanish producers have resulted in a great deal of activity in the Western states where deposits of the metal were known to exist, but which formerly could not be exploited profitably because of market conditions.

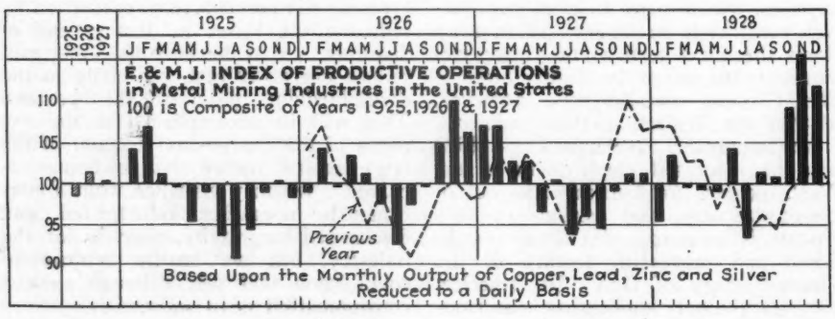
As a result of increased production and greater efficiency, dividends declared by the metal-mining companies were higher in 1928 than at any time since the war. Fig. 2, which shows total dividends for twenty representative American non-ferrous metal-mining companies during the last eleven years, indicates the general trend. Of the companies considered in preparing the chart, nine were copper-mining companies; six, silver-lead-zinc companies; two, gold companies; and three, diversified-interest companies.

Production from Arizona mines was naturally stimulated by the higher prices obtained for copper during 1928, but, as most of these increases came in the last half of the year, the full extent of the expansion in operations will not be reflected in the annual statistics.

Probably the most important increases in ore reserves made during 1928 among the Arizona mines resulted from the exploration campaigns being undertaken along the Dividend fault in the Bisbee district by the three large producing companies in that camp. Calumet & Arizona proved the continuation of its high-grade Campbell orebody below the 2,200 level by diamond drilling from that point. Plans for sinking to 2,500 ft. and remodeling the Campbell shaft so that it can be used for hoisting ore have been announced.

At the Denn mine of Shattuck Denn Corporation favorable results have also been obtained in opening up the orebody that was discovered late in 1927. A new electric hoist, which can handle 700 tons daily, is being installed and production from the new find is expected to start during 1929. Phelps Dodge completed its Warren shaft to the 2,200 level. Drifts are now being driven on three levels to explore the Phelps Dodge holdings along the Dividend fault. A separate exploration program, to take four years and to cost about $2,000,000, has been started by the company.

Fig. 1—Index of productive operations


1925
1926
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J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
E. & M.J. INDEX OF PRODUCTIVE OPERATIONS
in Metal Mining Industries in the United States
100 is Composite of Years 1925, 1926 & 1927
110
105
100
95
90
Previous Year
Based Upon the Monthly Output of Copper, Lead, Zinc and Silver Reduced to a Daily Basis

Production in Arizona in 1928

Metal	Bureau of Mines Estimate Amount	Value
Copper, lb.	736,282,000	$107,497,000
Gold, oz.	190,000	3,930,000
Lead, lb.	14,767,000	901,000
Silver, oz.	6,943,000	4,062,000
Zinc, lb.	1,200,000	72,000
Total		$116,462,000

At its Morenci branch, a long tunnel is being driven to provide drainage for the Humboldt mine. Economies in metallurgical treatment are expected to result from the installation of new crushing equipment during the year. Miami Copper, in the Globe-Miami district, also installed considerable new mill equipment, among which was a 325-ft. thickener, designed to handle 18,000 tons of tailing daily, and said to be the largest of its kind in the world. In the same district, Old Dominion struck a new orebody on the 2,400 level, but development was hampered by a large flow of water. On the other hand, New Cornelia, operating at Ajo, had difficulty in obtaining sufficient water for its mill and leaching plant, and additional tunneling will be undertaken at a cost of $200,000 to provide the necessary quantity. The concentrator capacity at this property is to be considerably increased. At the end of the year output was about 4,000 tons monthly.

A third producer was added to the Verde district's list by the construction of the 300-ton Verde Central mill, controlled by Calumet & Arizona. Shipments will be made to the United Verde Extension smelter. Newmont Mining took an option on the entire properties of the latter company late in the spring, but it was dropped after objections by U. V. X. stockholders. Since then development work at the mine is said to have resulted favorably. United Verde, which showed one of the largest production increases in the state, engaged in considerable research work and completed construction of a new foundry for its smelter. At Hillside, Bagdad Copper started construction of a 50-ton experimental plant, which, it is hoped, will result in proving possible the exploitation of the large low-grade deposit controlled by the company.

In addition to United Verde and New Cornelia, large increases were shown by Calumet & Arizona and Phelps Dodge.

Outside of copper, the mining men of the state devoted their attention chiefly to quicksilver, tungsten, and the complex ore deposits in the Kingman district. In the Oatman district gold-mining operations were on about the same scale as last year. In September the Montana mine started operating its new 250-ton mill at Ruby.

In Utah the effects of higher copper prices were naturally most marked in connection with Utah Copper operations, which account for more than 90 per cent of the total output of the metal in this state. At the close of the year, 60,000 tons of ore was being mined and milled daily, as compared with 40,000 at

Production in Utah in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	290,044,000	$42,346,000
Gold, oz.	208,000	4,301,000
Lead, lb.	286,792,000	17,494,000
Silver, oz.	16,682,000	9,759,000
Zinc, lb.	97,034,900	5,822,000
		$79,722,000

the start. Complete electrification of the haulage lines at the open pit in Bingham Canyon, in an effort to cut production costs still further, was started. An order for twenty electric locomotives has already been placed. In addition, construction of a second precipitation plant was begun.

In the Park City silver-lead-zinc district of the same state, Silver King Coalition furnished the most important new developments of the year. Mill capacity was increased from 600 to 900 tons daily by the addition of new flotation equipment. Decreases from the Park Utah mine may offset this gain, however, and the total production for the mines in this district will probably be about the same. Utah's other important complex-ore area, the Tintic district, also maintained operations at about the same rate. In this area it was the North Lily mine that attracted most attention. Erection of new surface structures greatly facilitated production, and toward the end of the year the company paid its first dividend. The Eureka Lily mine, adjoining the North Lily, also showed a large gain. Other Chief Consolidated properties did not fare quite so well, but production was higher than in 1927. After successful development of hydrogen-ion control, in the grinding and flotation circuits, the Chief Consolidated mill started operating on oxidized ores in the second half of the year. Output from the Tintic Standard should be a little less than in 1927. In May, a strike of high-grade ore was reported at this company's Eureka Standard mine. Outside of these three large producing districts, there was comparatively little activity in the state. In Washington County, southern Utah, American Smelting & Refining acquired the Silver Reef mine and started sinking a three-compartment shaft.

Although Nevada's copper production is much less than Utah's or Arizona's, it probably benefited as greatly in proportion from the general prosperity of the industry. In the Ely district, which produces most of the state's output, operations were expanded at the Nevada Consolidated and Consolidated Coppermines properties. The latter company is undertaking an important exploration and shaft-sinking program.

The Mason Valley Mines smelter at Thompson continued operating throughout the year, but it is expected that it will soon be forced to close because of lack of ore.

Probably of more interest to the average Nevada mining man than the developments at the copper mines has been the remarkable growth of the state's quicksilver industry. The leading producer in the state at the end of the year was Nevada Quicksilver Mines, which started operating its new furnace at the property, near Lovelock, late in August. Output is at the rate of about 500 flasks a month. Other important quicksilver developments have taken place in Fish Lake Valley, where B. & B. Quick started a new plant; near Beowawe, where Nevada-Mexico is the most important operator; and east of Mina.

Nevada had its annual gold "boom" in February, when a strike was made near Beatty. Interest in Wahmonie, as the new camp was called, faded rapidly, however, and at the end of the year only one company remained in operation. Other gold-mining operations were continued on about the same scale as in 1927. In the Round Mountain district all the operating companies were consolidated to form Nevada Porphyry Mines.

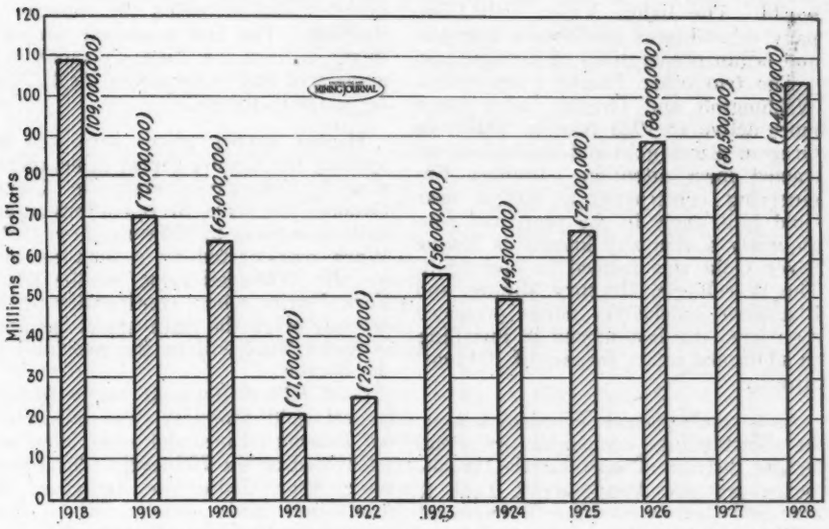


Fig. 2—Dividends of Twenty U. S. Mining Companies From 1918 to 1928

Nevada Metal Production in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	158,577,000	$23,152,000
Gold, oz.	172,500	3,570,000
Lead, lb.	15,784,818	922,000
Silver, oz.	5,401,000	3,160,000
Zinc, lb.	6,333,000	308,000
Total		$31,184,000

In the other non-ferrous metals, the most important development was the starting of construction of Treadwell Yukon's new concentrator at Tybo, where a large deposit of low-grade lead-zinc ore is being mined. This company also took an option on the Yellow Pine mine, at Goodsprings, but it was dropped later. Bristol Silver and Combined Metals at Pioche were the leading lead and zinc producers.

In the neighboring State of California, not much new work was undertaken during 1928. On the Mother Lode the fire which destroyed the surface buildings at the Kennedy mine curtailed the gold output of this property, but resumption of operations is expected early in 1929. Gold dredging will show a decreased production, although the number of dredges operated was the same.

Engels, Island Mountain, and Walker, among the copper mines, produced steadily throughout the year, the last named increasing its output to 1,200 tons daily. It is planned to enlarge the Walker mill to 2,000-ton daily capacity.

Operations at quicksilver mines showed the same expansion in California as in other states. New equipment was installed at the New Idria, Sulphur Banks, and La Joya mines, and a considerable increase in production is expected.

Operations at the Kramer borax deposit, controlled by Pacific Coast Borax, were put on a producing basis. This is now considered the most important source of the mineral in the

Table I—Production of Major Non-Ferrous Metals in the United States in 1927 and 1928

	1927		1928	
	Amount	Value	Amount	Value
Copper, lb. (a)	1,684,040,983	$217,578,094	1,849,000,000	$269,399,300
Gold, oz. (b)	2,207,000	45,418,600	2,194,295	45,360,100
Lead, lb. (a)	1,336,640,000	90,123,200	1,248,000,000	78,624,000
Silver, oz. (b)	60,434,441	34,266,000	56,020,268	32,771,857
Zinc, lb. (a)	1,153,920,000	72,120,000	1,166,420,000	69,985,200

(a) Obtained from Bureau of Mines releases. The value is computed by multiplying output by *E. & M.J.* average price for the metal during the year.
(b) Released by the Bureau of the Mint.

world. The Saline Valley Salt Company rehabilitated its 13-mile tramway and began preparations to produce salt.

The two other Pacific Coast states, Washington and Oregon, were much more active in 1928 than in 1927. In Oregon, placer gold and quicksilver attracted most attention. Ludlum Engineering constructed a dredge near Gold Hill, early in the year, and subsequently a company known as Rogue River Gold was formed to operate it. The War Eagle, Mercury Mining, and Blackbutte quicksilver mines produced regularly; the last named is installing an additional rotary furnace of 100 tons' capacity.

As a result of several consolidations, the outstanding companies in Pend Oreille district of northeastern Washington are now Pend Oreille Lead & Zinc and Grandview Mines. Diamond drilling indicates the existence of large low-grade lead-zinc deposits in both properties, and the plans for treatment plants are being drawn up accordingly. Grandview has practically completed construction of the first unit of a 1,000-ton mill. In the old Deertrail district, several mines were reopened and a new concentrator was built for Venus Silver.

Despite lower prices for lead, Idaho's non-ferrous metal production was about as large in 1928 as in the preceding year. In the Coeur d'Alene district, which is responsible for most of the Idaho output, completion of the new Sullivan electrolytic zinc plant will be reflected in a substantial increase over the 1927 zinc output, although operations were not started until October. This new plant is of great importance to many Coeur d'Alene mines that were previously penalized for the zinc content in their ores. It is believed that the Star zinc mine, owned jointly by Hecla Mining and Bunker Hill & Sullivan, will soon be reopened. New hoisting equipment was ordered late in the year for the main Hecla shaft, which handles the Star output. At the Morning mine, owned by Federal Mining & Smelting and situated in the same district, results at depth were so favorable that new equipment has been installed that permits operations at 1,000 ft. below the former tottom level. Late in the year a body of high-grade ore was struck on the 3,450 level which was unusual in its low zinc content.

The smaller companies were no less active. Golconda, Dickens, and Cedar Creek started new concentrators during the year, and Jack Waite Mining remodeled and increased the capacity of its plant. The first producing property in the district, the Tiger-Poorman, was unwatered and reopened by Hecla Mining early in the year.

Higher copper prices permitted reopening the Empire copper mine, owned now by Mackay Metals, in Custer County, the scale of operations gradually increasing to 150 tons of ore daily. Work was started on a flotation mill for the Whitedelf mine, in the Clark Fork district, where continuation of the orebody below the main tunnel has been proved. This will be the first mill in the district.

Gold Hill & Iowa, formerly Idaho's largest gold producer, was unwatered by Talache Mines and some new ore uncovered on the 700 level. The Idawa mine, near Centerville, increased its production and assumed first place among the state's gold producers.

Idaho Metal Production in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	2,117,000	$309,000
Gold, oz.	20,000	410,000
Lead, lb.	290,753,000	17,736,000
Silver, oz.	8,811,000	5,154,000
Zinc, lb.	60,360,000	3,622,000
Total		$27,310,000

Production in Montana in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	248,571,000	$36,291,000
Gold, oz.	62,500	1,296,000
Lead, lb.	32,662,000	1,993,000
Silver, oz.	10,726,000	6,275,000
Zinc, lb.	170,000,000	10,200,000
Total		$56,055,000

An increase in Montana's production is expected, for the same reason that it is looked for in Arizona, Nevada, and Utah—high copper prices. Zinc production will also be higher, despite a poor market throughout most of the year, because of the starting of a new electrolytic zinc plant at Anaconda in January. This new plant gives Anaconda Copper a zinc-producing capacity in Montana of 180,000 tons yearly. Anaconda's potential producing ability was increased by several other important steps. In September the W. A. Clark properties in Montana, including the Elm Orlu mine and the Timber Butte mill, were purchased for $5,000,000. Following the increase in the copper price, the Original, Steward, Badger State, and Belmont mines were all reopened. In addition, the Orphan Girl, carrying mostly zinc ore, was unwatered, and sinking of the shaft from the 1,000 to the 2,800 level has started. Toward the close of the year final steps were taken in centralization of the company's steam power supply. Hereafter, two main power plants, with a combined capacity of 5,000 hp., will serve all of the Anaconda properties on the "richest hill on earth."

In November North Butte, after a series of financial difficulties, was finally freed from its receivership, and a force of men started work at the Granite Mountain shaft. Butte & Superior obtained favorable diamond-drill results from the 3,600 level, and started to sink to 4,000 ft. In the southwest part of the district, several small companies did considerable exploration work, and some ore, in which silver predominated, was produced.

A new metal product was added to Butte's diversified list during the year. Famous already as a producer of gold, copper, zinc, silver, and lead, manganese ore is now being extracted as well. On March 15, Domestic Manganese & Development started its new nodulizing plant, which has a rated yearly output of 100,000 tons of 57 per cent ore.

Montana's gold production will probably show an increase in 1928 as a result of activity outside of Butte. Montana-Idaho increased the capacity of its Spring Hill cyanide plant to 225 tons daily by putting a second unit into production. Basin Cataract Mining was formed to acquire the Jib Consolidated mine, near Basin, once the largest gold producer in the state. In the same district, Basin-Montana Tunnel, a complex ore property, started a new tunnel to tap its orebodies.

A turning point in the fortunes of Colorado mining after several years of depression seems to have been reached in 1928. Probably the most important new metallurgical plant under construction in the state is a 500-ton underground concentrator being built for Empire Zinc, New Jersey Zinc subsidiary, at Gilman, Colo. This is expected to start in 1929 and will probably result in an increase of the state's zinc production. In the Leadville district, Colorado Zinc & Lead increased its mill capacity and Evans-Wallower Lead undertook an extensive exploration program. At Cripple Creek the Independence mill, operated by Portland Gold, was closed down late in the year, but better rates were offered by the railroad and by the Golden Cycle mill for shipments from mines in the district to the plant in Colorado Springs.

San Juan basin developments were generally favorable, although the famous Smuggler Union mine was forced to close after 53 years of operation, during which it produced $60,000,000. Exhaustion of ore reserves and increased costs were the most important factors in the shutdown. At the Sunnyside mine, the largest individual producer in the state, output has been increased from 850 to 1,100 tons daily by the installation of a new hoist at the Terry shaft and the addition of new flotation equipment to the mill. U. S. Smelting Refining & Mining, which owns the Sunnyside, is also developing the Hidden Treasure mine, at Ouray. The Rico-Argentine mine continued to ship

Production in Colorado in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	8,119,000	$1,185,374
Gold, oz.	253,644	5,243,287
Lead, lb.	54,036,000	3,296,196
Silver, oz.	4,131,465	2,416,907
Zinc, lb.	65,203,000	3,912,180
Total		$16,053,944

regularly to Salt Lake plants. Near Silverton, two mills were started by Shenandoah - Dives and Lackawanna Mining.

Production at the Rawley mine, near Bonanza, the largest copper producer in the state, will show an increase in 1928. Operations have resulted in a material increase in ore reserves, which show higher copper content at depth.

New Mexico Metal Output in 1928

Bureau of Mines Estimate

Metal	Amount	Value
Copper, lb.	88,214,000	$12,879,244
Gold, oz.	31,546	652,114
Lead, lb.	14,462,000	882,182
Silver, oz.	822,478	481,150
Zinc, lb.	65,658,000	3,939,480
		$18,834,170

As a result of the first full year of operations at the Pecos zinc mill, owned by American Metal, and increased output from the Chino copper mine of Nevada Consolidated, New Mexico production will also probably be higher for 1928 than for 1927. A new 7,500-hp. turbo-generator was installed to provide power for the Chino operations. Of the other copper mines, the Eighty-Five, owned by Calumet & Arizona, started to sink a new shaft. At the Burro Mountain branch of Phelps Dodge the leaching plant was dismantled and transferred to Douglas. A 100-ton zinc concentrator, constructed early in the year near Deming by Peru Mining, an Illinois Zinc subsidiary, was subsequently increased to 200 tons' capacity. A 100-ton selective flotation mill was also built for treating lead-zinc ore at the Black Hawk mine, near Silver City.

El Paso, Tex., has been selected as the site for the construction of the first copper refinery in the Southwest. On April 10, four important copper companies, Phelps Dodge, Nichols, Calumet & Arizona, and New Cornelia, entered into an agreement to undertake this work. The preliminary details are now being attended to, and the plant, which will refine 100,000 tons of copper a year, is expected to be ready for operation in the spring of 1930. The same companies have formed a new selling agency, known as Phelps Dodge Sales Company, with headquarters in New York.

The Terlingua district, in which the Chisos mine is the principal producer, was unusually active as a result of high quicksilver prices. American Metal acquired the Presidio silver mine, at Shafter, which accounts for most of the precious metal production of the state. It had been operated under lease to the company for two years previous to the purchase.

Bauxite production in Arkansas has increased. Total 1928 production was estimated at about 350,500 tons, as compared with 302,777 tons for 1927, an increase of almost 16 per cent. Most of this amount was, as usual, produced in Saline County by American Bauxite. The Pulaski County mines, however, have increased their output over that of 1927.

Miller & Rinehart, operating in the Batesville manganese district, report progress in working out a method to utilize low-grade manganiferous clays there. Clays containing 15 per cent manganese have been increased in grade to about 27 per cent by concentration. Arkansas' lead and zinc production is nearly at a standstill.

A decrease in production occurred in the Tri-State district for the third consecutive year. The companies operating in this field have borne the brunt of the lower zinc prices, and, although they could undoubtedly produce at a greater rate, even with present prices, they have been forced to refrain for fear of swamping the market. In the last two months zinc buying was speeded up and prospects in the district for 1929 are consequently better. The Tri-State Zinc and Lead Ore Producers' Association has modified its membership requirements, thereby increasing the number of companies included.

Concentrate Shipments From Joplin-Miami District During 1928

State	Zinc Conc. Short Tons	Value Zinc Conc.	Lead Conc. Short Tons	Value Lead Conc.	Value Lead and Zinc Conc
Oklahoma	368,861	$14,296,590	63,580	$5,243,530	$19,540,120
Kansas	208,010	8,144,490	36,315	2,995,100	11,139,590
Missouri	17,180	648,570	1,210	96,420	744,990
Totals	594,051	$23,089,650	101,105	$8,335,050	$31,424,700

By formation of the Evans-Wallower Lead Company early in the year, one of the largest producers in the district, Golden Rod Mining, was combined with an important manufacturer of lead products. Vertical integration of this sort is considered by many to be a possible solution to the pressing problem confronting the Tri-State companies that have fully developed and equipped their properties, but are forced to keep them idle. Evans-Wallower has since announced that it will construct an electrolytic zinc plant, similar in design to the Sullivan plant in Idaho, at East St. Louis, Ill., for the treatment of Western ores. The plant will have a 50-ton capacity and the cost is estimated at about $1,000,000. The Sullivan plant cost about $1,500,000. Sulphuric acid will be delivered to an adjacent chemical company.

Two other important mergers were consummated during the year: Consolidated Lead & Zinc, a subsidiary of Eagle-Picher Lead, purchased the entire holdings of Domado Mining for a sum stated to be $400,000, and Canam Metals, an organization of Canadian and American interests, took over five mines in the district.

In southeast Missouri, lead production in 1928 will probably show a small increase over that of the previous year. St. Joseph Lead has reopened the Mine La Motte property, and production is expected to start in March. St. Louis Smelting, National Lead subsidiary, purchased the Schulte Mining holdings, near Fredericktown. Development and equipment of the claims will be undertaken in the spring.

The Platteville zinc district, in Wisconsin, showed even a greater decline, proportionally, than the Tri-State field, shipments of zinc concentrate being less than two-thirds of the figure for 1927. The New Jersey Zinc Company has entirely withdrawn from the district, leaving Vinegar Hill Zinc as the only important producer.

Homestake Mining continues to be the largest gold mine in the United States, and by far the greatest single

Table II—Production of Gold and Silver in the United States in 1928.

Estimated by the Bureau of the Mint

States	Gold Ounces	Gold Value	Silver Ounces	Silver Value (a)
Alaska	309,668	$6,401,400	463,423	$271,103
Arizona	184,522	3,814,400	6,346,744	3,712,845
California	522,822	10,807,700	1,409,525	824,572
Colorado	253,577	5,241,900	3,973,410	2,324,445
Georgia	24	500	4	2
Idaho	20,545	424,700	8,877,857	5,193,546
Illinois	.....	.....	2,616	1,530
Michigan	.....	.....	4,349	2,544
Missouri	.....	.....	151,736	88,766
Montana	57,644	1,191,600	10,001,981	5,851,159
Nevada	174,895	3,615,400	5,391,732	3,154,163
New Mexico	31,705	655,400	799,414	467,657
North Carolina	34	700	3	2
Oregon	9,656	199,600	28,234	16,517
Pennsylvania	895	18,500	6,724	3,934
South Carolina	19	400	4	2
South Dakota	320,112	6,617,300	89,634	52,436
Tennessee	624	12,900	94,987	55,567
Texas	585	12,100	1,391,295	813,908
Utah	205,226	4,242,400	16,855,729	9,860,601
Washington	15,557	321,600	94,495	55,280
Wyoming	34	700	13	8
Philippine Islands	86,151	1,780,900	36,359	21,270
Totals	2,194,295	$45,360,100	56,020,268	$32,771,857

(a) Value at 58.5c. per ounce, the average New York price of bar silver.

contributor to the South Dakota metal output. Production for the year is about the same as last. In October Trojan Mining started to reopen its property, also in the Lead district. A new 1,700-ft. tunnel will be driven to intersect the Two Johns vein. Construction of a tin concentrator at Tinton by the Black Hills Tin Company is reported.

In the Lake Superior iron country, 1928 was, on the whole, very satisfactory. For the eleventh time, shipments of ore exceeded 50,000,000 tons. Total tonnage shipped by water was 53,980,874 tons and all-rail shipments will bring the mark to more than 55,000,000. Stocks on hand at lower Lake ports are less than a year ago. About 30 per cent of the ore now being shipped from Minnesota mines is being washed at the mines. Ten years ago, this figure was only 10 per cent. Practically no ore from the Michigan and Wisconsin ranges is so treated.

Michigan will not show the same increase in copper production as the other important copper-producing states, because of lack of available labor. However, the value of the output will naturally be greatly increased by the rise in price. Greater profits for some of the comparatively high-cost Michigan producers will probably result from the adoption of flotation, as recommended by the Bureau of Mines following an investigation into the possibilities of this method of treatment in connection with the native copper deposits. Savings of about 3 lb. per ton are indicated.

Seneca reopened its mine, which had been closed for a year and a half, in the latter part of 1928, and Calumet & Hecla prepared for resumption of operations at the No. 17 Osceola shaft. This company also undertook an extensive exploratory campaign in Keweenaw County, including unwatering and exploring the old Cliff and Phoenix shafts. At the company's smelter, the work of modernization continued.

Quincy Mining completed repairing its No. 2 shaft, which had been damaged by fire in 1927. The company plans to put operations on a basis of 4,000 tons daily.

In Tennessee, the discovery of new high-grade orebodies in the Mascot zinc mine, belonging to American Zinc Lead & Smelting, was reported. The company also undertook the development of its Jarnagin lease, near Jefferson City. In the Ducktown district, the two operating companies, Tennessee Copper & Chemical and Ducktown, naturally benefited from the increased copper price, and production was increased somewhat.

Along the Eastern seaboard, which for many years has been of negligible importance in copper production, the effect of higher prices was also manifested. In North Carolina, the Fontana mine, Swain County, was shipping 700 tons of ore daily at the close of the year. The production for the year will be close to 12,000,000 lb. The total value of minerals produced in the state will probably reach a new high mark. In the Piedmont belt, three old gold mines are being developed on a small scale. Several important developments have taken place in non-metallics. The state now has a daily feldspar grinding capacity of 290 tons as the result of the construction of a new small plant and additions to existing ones. Four new mica recovery plants have been constructed and a new 80-ton talc plant also began operations.

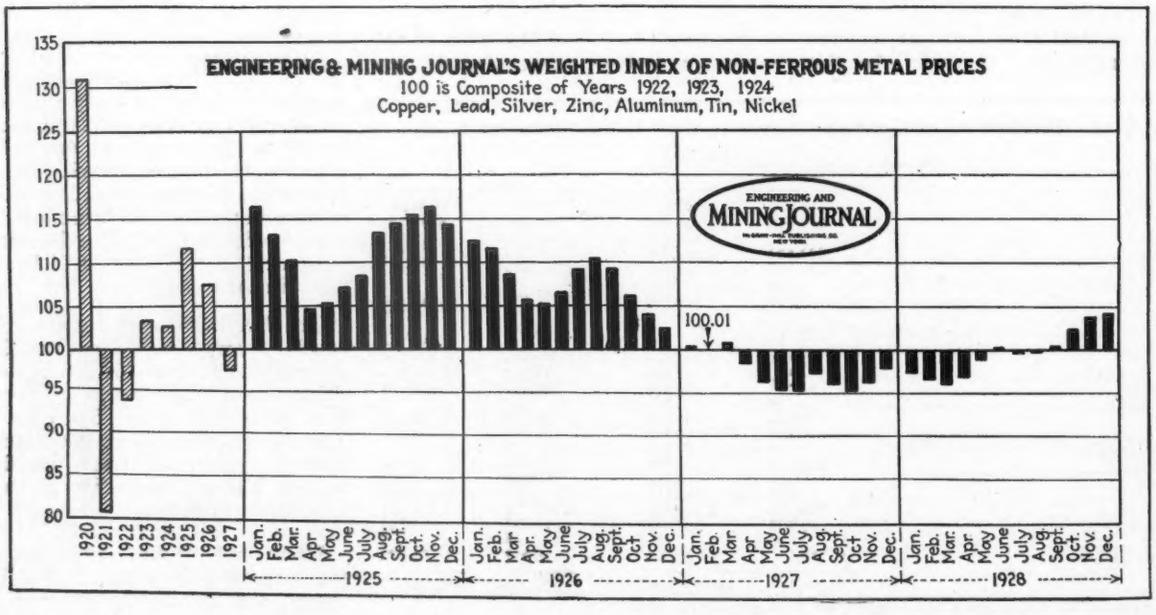
Some attempts are being made to reopen gold mines in South Carolina which have been closed for many years. Clay production from this state has increased.

In Virginia, there was also some activity in development of known copper deposits near the North Carolina border. The old Whitehall gold mine, which produced considerable gold before the Civil War, is being reopened, and activity in manganese mines is also greater. New Jersey Zinc is operating a 750-ton mill on zinc ore from deposits near Austinville. Production is expected to be about 11,000 tons of the metal. This company also continued operating its mines in Sussex County, N. J. In New York, St. Joseph Lead operated the Edwards zinc mine. Output has been considerably increased by the new flotation plant.

The old Elizabeth copper mine, in Vermont, is also being reopened, and production is expected to start in 1929.

In Alaska, outside the boundaries of the United States proper, copper production declined considerably, but the value of the output did not change greatly, because of higher prices. Most of the production comes from the Kennecott and Mother Lode properties. Gold production will be higher than in 1927 because of the activities of U. S. Smelting Refining & Mining at Fairbanks. Three dredges were put into operation, and a production of about $800,000 was recorded, although operations were not started until late in the season. A new boom has resulted from this work in the Fairbanks district, and installation of several other dredges is planned. Prospecting was very active through the year, copper and tin being the metals chiefly sought. British companies are reported to be developing some tin prospects.

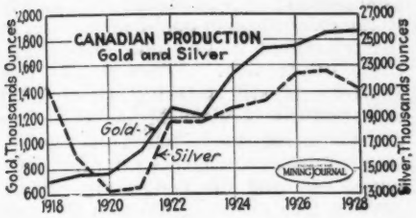
Chichagof Mining reopened the old Chichagof mine, on Chichagof Island, and started production late in 1928. Construction of a flotation plant to make a zinc concentrate is planned at the Alaska Juneau gold property.



Canadian Mining Progress

By Reginald E. Hore

CANADA is steadily forging ahead as a mining country. Output is increasing, and greater facilities for the treatment of ores are being provided. Hand in hand with the growth of the industry goes the development of water power. The production record for 1928

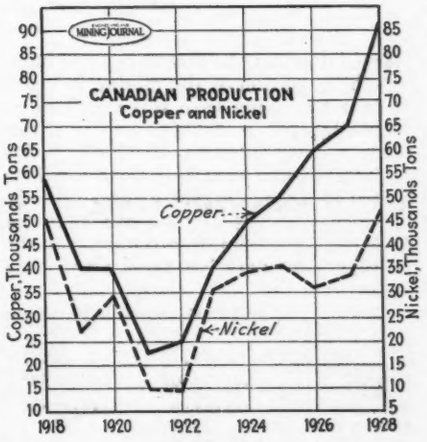


will show that operating mines of the country bettered all previous records. Recent developments at some of the mines, and the progress in making new ones, indicate that the Dominion will in a few years be producing much greater quantities and also refining a larger percentage of the mine output.

Although progress at proven mines was statisfactory, greater interest in new fields prevailed. During the year increased numbers took part in prospecting and development enterprises in Canada. From coast to coast and from the Great Lakes to the Arctic a vigorous search for valuable minerals was begun. Exceptional progress in exploration of the North was made, utilization of airplanes being largely responsible for the activity in scouting and prospecting areas that have hitherto been rarely visited. One aviation company, the N.A.M.E., organized during the winter of 1927-28, has undertaken with considerable energy the "cracking open" of the North, and has a fleet of airplanes working from several bases. Western Canada Airways greatly expanded its business as a public carrier, and has done fine work in helping to speed up the activities of those who prospect and travel in places distant from the railways. In addition to the operation of these two companies, many privately owned airplanes are now being used by prospecting syndicates. Among the expeditions in 1928 were several to Chesterfield Inlet. In the development of new camps not yet reached by railroads, or wagon or motor roads, the airplane is assisting greatly in pioneer work. Supplies and men are transported rapidly and safely under summer or winter conditions. Western Canada Airways, which serves many mining companies, has made an outstanding record by delivering in good order everything carried over its lines. Lakes abound in the North, and planes are supplied with pontoons in the summer and with skis in the winter. Planes so equipped can land on or close to areas of interest to prospectors. Pilots are rapidly becoming authorities on the geography of the North.

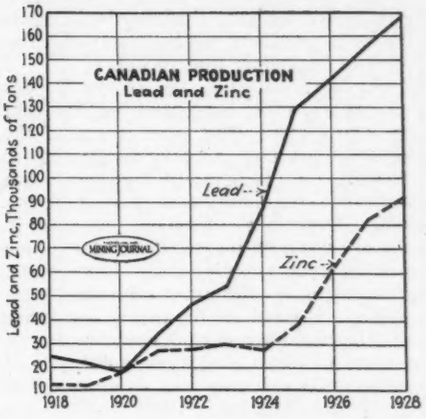
Chart data from Dominion Bureau of Statistics.

Important developments have resulted from recent exploratory work in many parts of the dominion. Both new and old areas have received attention, but the greatest interest has been in the Sudbury, Noranda, and Flin Flon districts. Activities at Sudbury during the last two years have been particularly noteworthy. The Frood ore deposit is evidently to be the nucleus of a much greater industry than the already well-known enterprises of the nickel-copper companies there. Early workings of the deposit yielded 110,545 tons of ore averaging 2.66 per cent nickel and 1.39 per cent copper. Ore of that grade does not enthuse the owners of Creighton mine; but, as subsequent diamond drilling showed several million tons of such ore, the two owners—International and Mond—made preparations just before the war to mine it. Development work was done, and then, attention being directed from exploration to production, operations were suspended until war demands for metal had been satisfied. The two companies a few years ago resumed exploration of the Frood orebody and found that the early work was in a comparatively low-grade portion of the deposit. Much richer ore has been found at depth, and this discovery is causing tremendous changes in the industry. An estimate has been made that $12,000,000 will be spent during the



next three years on the mine, smelter, power plant, and additions to the refinery of International Nickel. New financing by the Mond company is to be made for corresponding improvements. The Frood development is the foundation for the proposed merger of the interests of the two companies.

The deposit, which is chiefly on International Nickel property, strikes northeast across the southeast corner of a Mond lot; and, as the dip is northwest, the Mond portion is much larger and richer at the lower levels than it is above. The International shaft is down 3,000 ft. and the Mond 3,300 ft., and crosscuting to the ore has been in progress. During 1929, development of the orebody will be pursued, and mining operations will be carried on below the 1,200 level, leaving for the present the 60,000,000 tons of lower-grade ore al-



ready developed. The sinking of the two deep shafts to mine Frood ore is an interesting story, and an account of these achievements will doubtless be published soon. Surface plant at the Frood mine is planned for large-scale, long-continued production on a scale that is indicative of the expectations of the management. The Frood will be Canada's best-equipped mine.

During 1929, the Copper Cliff metallurgical works will be enlarged. Other departments having been placed in operating order, the capacity of the smelter is to be increased for the larger enterprise that is planned. In the new order, Sudbury will be a much larger producer of copper and precious metals, as well as a substantial producer of nickel-copper matte. According to intimations, Creighton mine ore will be used chiefly for making Monel metal, and Frood ore, which has a higher copper and precious metal content, will be treated to yield the desired increase in total value without increasing nickel output beyond the needs of the market. A proposal has been made to build a refinery at Copper Cliff for the recovery of copper, gold, and metals of the platinum group.

While the two producers in the nickel-copper area were negotiating a merger, a new enterprise was being launched there. The Falconbridge Township property, which was drilled by the E. J. Longyear interests, and which is situated a short distance east of the Garson mine of the Mond company, has been purchased, for $2,500,000, by Ventures, Ltd. Drilling showed a large body of nickel-copper ore. The new company has begun development and shaft-sinking operations.

Sudbury is also the scene of another type of mining enterprise. The Tread-

well-Yukon Company, controlled by the Bradley interests, is developing a large deposit at the Errington mine. The ore is a mixture of sulphides of copper, lead, and zinc. Three shafts have been sunk, and exploration is in progress. A pilot mill of 300 tons' capacity has been installed, and satisfactory treatment results are reported. An adjoining property, Sudbury Basin Mines, Ltd., also managed by Joseph Errington, has obtained good results from a diamond-drilling campaign. Sudbury is therefore to be a producer of lead and zinc, as well as of copper and nickel.

At Noranda, Que., the Horne Copper Corporation has completed its first year as a producer. The mine is one of the most important so far discovered in Canada, the ore being of high grade and sufficient in quantity to permit large-scale operations. Copper and gold in the ore occur in masses of solid sulphide and in gray rhyolite with chalcopyrite. Pyrrhotite is the most abundant sulphide, and much of the ore is a mixture of this sulphide and chalcopyrite. Large masses of clean chalcopyrite occur, and such ore is not only rich in copper, but is also gold bearing. Siliceous flux used at the smelter, which is also obtained from the same mine, carries about 2 per cent copper and one or two dollars in gold. Treatment of 800 tons daily of Horne mine ore has resulted in large profits, and developments at the mine during 1928 greatly increased ore reserves. Moreover, exceptionally good results have been achieved in the operation of the smelter. The Noranda enterprise is, therefore, now well established, and a general expansion of mine and smelter operations is being considered. One furnace is treating the output of the Horne mine and also some ore from the Waite mine. In 1929, however, a second furnace will probably be operated. A 500-ton concentration plant, which will be used chiefly to separate copper and zinc in ore from other mines, was completed at the smelter last November. Some zinc is found in the Horne ore, but much of the output is free from zinc, and treatment of this portion is not necessary. Regular shipments are being made from the Waite property. Developments at the Abana, Amulet, and Aldermac mines indicate that considerable copper-zinc ore will be produced in the Rouyn area in the near future. Apparently the Horne smelter and the town of Noranda have a long period of prosperous times ahead of them.

In Manitoba, the Flin Flon mine f Hudson Bay Mining & Smelting and the Sherritt-Gordon mine are outstanding. At the Flin Flon, a pilot mill has been in operation, and processes for treating the ores there have been successfully developed. A railway has been built to the mine, and equipment is being taken in to construct a hydro-electric power plant on the Churchill River. Plans of the company include the erection of a 3,000-ton concentrator during 1929.

The Sherritt-Gordon, like the Flin Flon, is a copper-zinc property. It has only recently been drilled, but already is conceded to be one of the coming big copper-zinc mines of the country. An extensive campaign of drilling, together with underground work in two sections 7,000 ft. apart, has indicated that the deposit is large and of commercial grade. Announcement has been made that the Canadian National branch line to the Flin Flon property will soon be extended to the Sherritt-Gordon mine.

Search for precious metals continued to draw many prospectors to northern Canada during 1928. The most noteworthy discoveries were made on claims held by the Connell and Hammell interests that are north of the Canadian National Railway in the Patricia district of Ontario. Confidence prevails that Patricia will be an important gold producing region. During 1929 many prospectors will be attracted to the district, as a gold-bearing area two hundred miles long has been found. The first important producer will undoubtedly be the Howey property, at Red Lake, where a 500-ton mill is to be erected following the construction of a power plant at Ear Falls.

In the gold-producing areas of northern Ontario, increased output at some mines was offset by decreases at others. Total production for 1928 will be about the same as that for 1927. Several promising discoveries were made in the Kirkland Lake area during the year just past.

Mexico in 1928

By W. L. Vail

According to government opinion, the condition of the mining industry in Mexico during 1928 was satisfactory. Notwithstanding the decline in silver, lead, and zinc prices, production was maintained and even surpassed previous zinc and antimony production records. Complete returns are not available for 1928, but government estimates for the year and comparative figures for 1927 follow:

	1928 Production in Kilos	1927 Production in Kilos
Gold	22,000	22,556
Silver	3,252,000	3,252,688
Lead	227,430,000	243,346,147
Copper	58,511,000	58,733,724
Zinc	155,065,000	136,477,888
Mercury	78,000	81,115
Antimony	3,167,000	1,924,115
Arsenic	7,780,000	9,017,920
Graphite	5,356,000	5,836,689

The slight rise in the price of silver during May and June did not lead to increased production, and general opinion is that the maximum silver production for some time has been reached. Output of the Pachuca group during the first nine months of the year was slightly less than that for the same period of 1927.

Decreased production at the Erupcion and Año Nuevo mines, in the Lamentos region, State of Chihuahua, resulted in a decline of 16,000 tons in lead output of the country, as compared with the figures for 1927. Increased production of zinc was due largely to expansion in the treatment of silver-lead-zinc ores by selective flotation. Although copper quotations improved, production remained unchanged. The strike of 2,500 miners at the El Boleo mines, Santa Rosalia, Lower California, reduced output during the last three months of the year. The falling off in gold production was mainly attributable to the exhaustion of gold-bearing ores in the regions of El Oro and Tlapujahua, State of Mexico. Although the Dos Estrellas is still working about 2,500 men, and the Mexican Mines of El Oro are preparing to install a tailing retreatment plant, deposits are practically mined out and the camps are rapidly passing into history. Most of the gold produced in 1928 was obtained in the treatment of silver-lead-zinc ores. Increased production of antimony was almost entirely the result of a larger output at Wadley, in San Luis Potosi. The decline in the production of mercury was caused by a temporary suspension of work in the Huahuaztla district of Guerrero, where modern furnaces are being installed. A number of properties, however, are being worked, and the output in 1929 should show a material increase.

In the State of Guerrero, the Peñoles company greatly increased development work at the Suriana mine and placed a 300-ton cyanide plant in operation that will be used for ores previously treated by chlorinization. Construction of an automobile road to connect with the Balsas River was also undertaken. The Chontalpam company completed and operated successfully a 150-ton cyanide plant at Xitinga. Monte Carlo company constructed a 50-ton flotation plant and did considerable development work. In Huahuaxtla, Tasco, Castro, Hernandez & Company installed a furnace of 25 tons' capacity for the treatment of mercury ores from their properties at La Aurora. Several small quicksilver and gold properties in Huitzuco were opened during 1928.

The Santiago Mining Company, operating in the Huautla district of Morelos, completed a 300-ton flotation plant for the treatment of complex ores. La Compania Mexicana de Minerales, with a property near Mazatlan, Sinaloa, the principal port of the state, constructed a 50-ton plant, which may be increased to 100 tons' capacity during 1929. Ores from southern Sonora and the State of Sinaloa hitherto unmarketable will be treated at the plant. Considerable activity also prevailed in the Panuco district, southern Sinaloa. The old Tajo property, at Rosario, suspended operations. Cinco Minas, in Jalisco, mined about 600 tons of gold and silver ores in 1928. Oest, Martinez & Company opened up the Ojo de Agua and installed a furnace for the extrac-

tion of mercury. A commission began a study of the mining situation in the Amparo and Piedra Bola camps with the view of preventing the closing of these properties. Both state and federal authorities, according to report, are disposed to reduce taxation greatly in order to keep properties in operation. Prosperous conditions prevailed in Chihuahua. San Rafael y Anexas, of Pachuca, began an extensive development campaign in the Parral district, and most of the large companies in the state operated steadily. Some new developments were reported from the Dolores properties in the Concheno district.

Cia. Carbonifera de Sabinas enlarged its zinc distillation plant at Rositas, Coahuila, from a capacity of 1.5 to 5 tons every 24 hours. Although several properties were closed in the Ocampo and Cuatro Cienegas districts, a number were also opened. American Smelting & Refining began the construction of a lead refinery at Monterey, Nuevo Leon. The refinery is to cost about $1,000,000 and will be placed in operation early in 1929. Entrance of the Potosi interests of Chihuahua into Zacatecas has aided the mining industry of the latter state. Moral company placed a new flotation plant in operation, and the hacienda at Calvario periodically treated lead ores. Operations at the large plant in Fresnillo continued at a normal rate, and the Mexican Corporation plans to increase production during 1929. The new owners of San Miguel del Oro plan to begin production early in 1929. La Noria continued to operate at a normal rate. The recent opening of the old San Martin mines by a Canadian company, and continued development of the properties of Majestic Mining, in the district of Totoloapam, were outstanding events of 1928 in Oaxaca. Reports from the Angangueo unit of American Smelting & Refining indicate increased activities as a result of a new strike at the Dolores mine in Michoacan.

During 1928 a national organization was established to promote first aid and safety in the mines of Mexico. At the first field meet held eleven teams competed and demonstrated considerable knowledge and skill. In the course of the year 1,770 requests were filed at various mining agencies for exploration and exploitation permits. This number represented an increase of 8.2 per cent over the figure for the previous year. About 18,000 active concessions were estimated to be in force at the close of 1928. Most of these concessions were situated in Chihuahua, Sonora, Durango, and Guerrero. Few labor disturbances occurred in Mexico during 1928. The federal government began the preparation of a labor law which it is hoped will minimize differences between employees and employers. This proposed law will probably be considered at a special session of Congress to be called early in 1929, for the specific purpose of enacting labor legislation.

The Mexican Supreme Court rendered an important decision in November, 1928, interpreting the mining laws to the effect that when additional development work was in evidence on mining properties, such properties were per se withdrawn from provisions of denouncement, but subject to lease by the government. The decision was far reaching and covered a number of cases then under litigation.

Political conditions were normal throughout the country during the year, with the exception of certain territories in the states of Jalisco and Zacatecas. Transfer of the presidency took place on Dec. 1, the provisional incumbent, Portez Gil, having the unanimous support of both houses of Congress and the army chiefs. His term is for fourteen months from date of occupancy, and elections for president for the six-year period will take place in December, 1929.

South American Expansion Continues

By S. D. Strauss
Editorial Staff

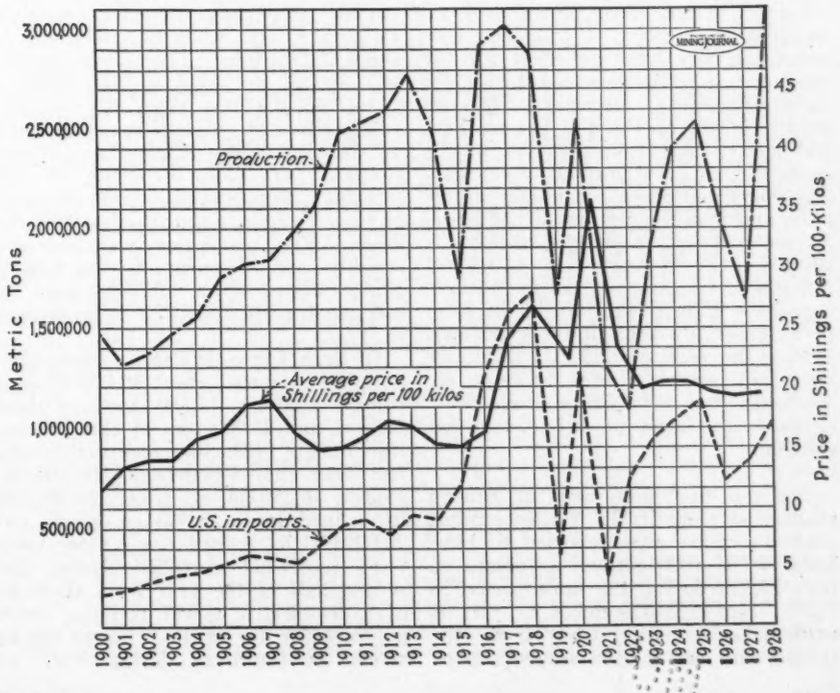
SOUTH AMERICA during 1928 continued its steady growth in importance in the mining world. The nitrate industry is well on its way back to prosperity; copper production has increased in Chile and Peru, as elsewhere, in response to the tremendous consuming demand; Bolivia's tin industry, despite lower prices, more than held its own as the result of expansion by the leading producer; gold and platinum will also probably show increases when the final figures are compiled; and silver, lead, and zinc have at least fared as well as in former years.

Chile, which produces most of the copper and all of the nitrate, deserves attention first. Fig. 1 illustrates the vicissitudes through which the nitrate industry has passed in the last 28 years. For a detailed analysis of the conditions in this industry, the reader is referred to the article by Mr. Huntington Adams, on p. 102.

Among the copper mines the operations of the three American-controlled companies—Andes, Chile, and Braden—were the most important, contributing, as they do, about seven-eighths of the country's output. As indicated in Fig. 2, production in 1928, for the first time, probably reached a total of 300,000 metric tons.

Chile Copper continued its program of electrification of plant and mine railways at Chuquicamata. At the end of 1928, twelve electric locomotives were in operation. Two additional electric locomotives, now on order, will be delivered and put into operation early in 1929. Two 80-litre per hour liquid-oxygen units were also under construction at the end of the year, and will provide this additional capacity to the L.O.X. plant already in use. Opportunity was afforded during 1928 to try out under actual operating conditions

Fig. 1—This chart shows the fluctuations in price, production and United States imports of Chilean nitrate since 1900. Data were obtained from a handbook of the producers' association.



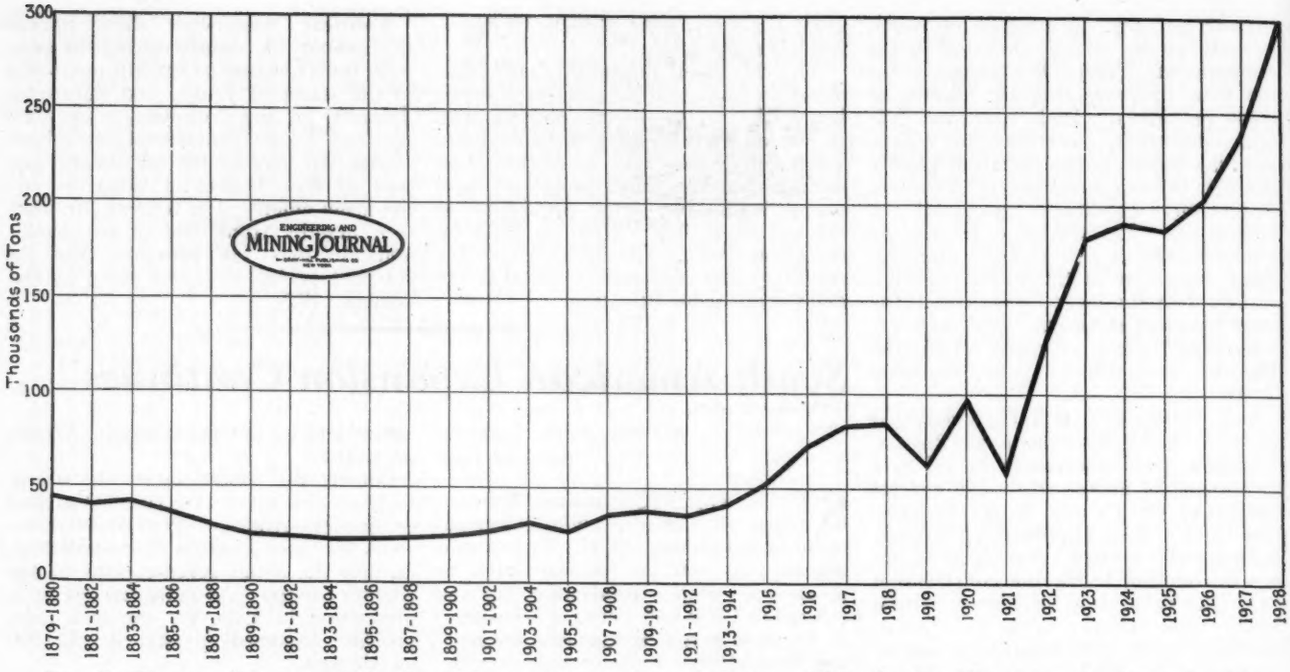


Fig. 2—The startling growth in the Chilean copper mining industry within the last few years is shown in this chart. Figures used from 1879 to 1914 are the yearly averages for the two year periods, not the totals.

the new units of the plant completed in 1927. They have functioned smoothly. During the first nine months of 1928, 6,400,801 tons of ore, averaging 1.589 per cent copper, was treated and 182,043,747 lb. of copper was produced. Final figures for the last quarter were not available at the time of going to press, but a comparison of the figures for the first nine months of 1928 with those for the first nine months of 1927 indicates that the production for 1928 will be greater than that during 1927.

Andes Copper Mining operations at Potrerillos during 1928 were characterized by the completion of the extensive construction and development program initiated in January, 1925. The concentration and smelting plant for the treatment of 12,500 tons of sulphide ore daily, completed in December, 1926, has been in steady operation. The leaching and electro-deposition plant to handle oxide ore, of 7,500 tons' daily capacity, was completed about the middle of the year, and immediately put in operation. Blister copper from the smelter is shipped to Perth Amboy, N. J., for refining, and fine copper from the electro-deposition plant is shipped, in the form of wirebars, directly to the consumer. During the year a number of dwellings were built at the mine townsite to accommodate the increase in forces occasioned by the initiation of oxide ore extraction.

For the first nine months, Braden production from its El Teniente mine, near Rancagua, was reported to have been 77,195 metric tons, as compared with 73,219 during the same period in 1927. Early in December, a serious earthquake in central Chile broke the tailing dam and caused severe loss of life. This accident necessitated curtailing operations about 50 per cent.

At the Tamaya mine, south of Coquimbo, American Smelting & Refining, under the terms of its option, continued to drive a long crosscut tunnel to cut the main vein at a depth of 600 meters below the outcrop. The objective should be reached early in 1929.

Tocopilla Mining practically completed electrification of its equipment during the year. A 700-hp. Diesel engine has been installed at Tocopilla to provide power. The combined production from Tocopilla and the other small copper properties, notably Poderosa, Disputada, and Chagres, amounted to about 25,000 tons. The Gatico smelter was started up again in September.

During the last year, no new developments or installations occurred at the Bethlehem Chile Iron Mines property, at Tofo, Province of Coquimbo. Shipments are from the port of Cruz Grande, about 6 miles from the mine. The properties were worked steadily, and shipments to the United States totaled about 1,550,000 tons, as compared with 1,495,272 tons shipped in 1927.

In Peru, Cerro de Pasco Copper Corporation produced about 50,000 tons of copper bullion; 15,550 tons of lead bullion, and 22,000 tons of zinc concentrate during 1928. The recoverable content was approximately 97,500,000 lb. copper, 16,250,000 oz. silver, 29,000,000 lb. refined lead, 25,000 oz. gold, and 20,000,000 lb. refined zinc. Operations were somewhat curtailed during the second half of the year by a shortage of hydro-electric power resulting from an unusually dry season. Power supply should be improved during 1929, as the first unit of the addition to the Pachachaca hydro-electric plant started operating in November. During 1928 a drainage tunnel to dewater the Morococha mines was authorized. This tunnel will start at Mahr, on the Yauli River, and extend about 30,000 ft. to the Central shaft. Four to five years will probably be required for its completion. It will reach the Central shaft about 600 ft. below the present 1,000 level, the lowest now reached from surface. Preliminary arrangements are now under way, camps are being built, and compressors and drills have been ordered. A. Guthrie & Company, who drove the Cascade tunnel, will act as consulting engineers and will supervise the work, furnishing superintendents and men.

A second lead furnace has been authorized by Cerro de Pasco, but production will probably not begin until late in 1929. The question of a Betts lead refinery in Peru is still under consideration. Promising progress is being made in the effort to find a method to recover the lead, silver, and bismuth in large stocks of flue dust and of the current production of converter flue dust. A trial shipment of 20 tons of high-bismuth bullion, now being produced from this flue dust, will be shipped to a United States refinery. Should this trial prove profitable, regular shipments will follow. Additional Cottrells are under consideration.

Experimental pilot-plant operations on Cerro low-grade refractory oxidized silver ores, referred to locally as *pacos* ores, are progressing encouragingly. Plans for a 2,000-ton daily permanent *pacos*-pyrite plant are now being prepared in Peru. They will probably be

completed early in 1929. By that time, it is hoped, pilot-plant results will be sufficiently definite to justify proceeding with construction of the larger plant.

Zinc concentrates from Casapalca were exported to Europe. Experimental tests on concentration of Cerro de Pasco lead-zinc ores have proved satisfactory; and estimates on concentrators having a capacity of 1,000 to 2,000 tons per day are being made. The question of a zinc refinery in Peru is still being considered, and additional hydro-electric power possibilities are being followed up. The new research building at Oroya is about completed; equipment is being installed and the technical organization enlarged.

Northern Peru Mining & Smelting continued development and operation of its properties in the Department of La Libertad. The mill at Samne was operated during the entire year on ores from the Diana mine, in the Salpo district. The Quiruvilca mine was also operated throughout the year, ore being shipped to Shorey by cable tramway. The mill and smelter at Shorey operated satisfactorily. Construction is now being started on a Cottrell plant to treat the flue gas from the smelter. In addition, construction of a Dwight-Lloyd sintering machine, and accessories, is under way. The Pataz mine was operated for the greater part of the year. Development of the Chilete mine was continued. No decision has yet been made regarding placing the property on a producing basis.

In Bolivia, the principal activity is that of Patiño Mines & Enterprises Consolidated, whose tin production amounted to about 17,000 metric tons, or from 8 to 10 per cent of the total tin production of the world, as estimated at the end of the year. In 1927, the mill handled an average of 822 tons daily, but additions and improvements enabled it to treat about twice this, or 1,700 tons a day, by the end of 1928. The grade of ore handled was about 4.7 per cent tin, which was concentrated to a product averaging about 64 per cent tin for shipment to the English smelters. This marked increase in capacity enabled the company to earn a little more than in 1927, even though the price of tin was markedly lower.

In the remodeling, modern breaking and sorting equipment has been installed; rail transportation is now used instead of a cable tram from mine to mill; a new crushing and conveying plant was constructed at Catavi; more Diesel engine equipment was acquired to supplement the hydro-electric development at Lupi-Lupi; and, many improvements were made in the concentrator. Flotation is employed to purify the tin concentrate from sulphides.

Ludlum Engineering, of New York, optioned the Huanuni tin placers. Construction of a dredge is expected to start soon. Estimates place the developed yardage at 15,000,000, averaging 2½ lb. of cassiterite.

Secondary to the Patiño company in importance in Bolivian tin production is the Caracoles Tin Company, controlled by Guggenheim Brothers, of New York. Operations have continued at about the same rate as before at the vein mines, but the dredge, which was installed about two years ago, has improved its performance. Incidentally, this is the only operating dredge in the country. No other new equipment of importance has since been added.

Aramayo Mines has recently passed under the management and administration of the Caracoles company, which, it is understood, has obtained a partial stock ownership. It is also the world's largest bismuth producer, but it is most important as a producer of silver and tin.

Production from the Ocuri mine, also a tin producer of considerable importance, was greatly increased in 1928. During the first ten months of the year the total production of concentrate exceeded the 1927 output of 85,889 quintals, or about 4,250 tons. At the end of that period operations were on a basis of 9,000 quintals monthly.

Important metal mining operations in Ecuador remain limited to the work done by South American Development, which operates gold and silver mines in the Zaruma district. Records for the first nine months indicate that about 70,000 oz. of gold and 78,000 oz. of silver were produced during 1928. A second hydro-electric generating unit, similar to that installed in 1926, has been added to the equipment, as well as a large electric hoist and storage-battery locomotives. Interest in the old Lluvia del Oro district, in Esmeraldes, has been revived with the resumption of exploration by an English syndicate headed by Major R. H. Thomas.

Progress in the financial rehabilitation of the country has been continued following the recommendations of the Kemmerer commission, and, with increased taxes and improved supervision of both collection and expenditure, indications are that the government's fiscal year will again show a surplus balance as it did in 1927.

During 1928 three dredges were operated in Colombia, in the Condoto River valley, by South American Gold & Platinum, and preliminary work has been started on the installation of the second unit at the hydro-electric power plant on the Andagueda River. It is estimated that the 1928 production of platinum will be about 25,000 crude ounces Troy, as compared to 21,992 crude ounces Troy in 1927; and 8,000 oz. gold in 1928, as compared to 6,363 oz. in 1927.

Production from the Silencio mine of Frontino & Bolivia, in the Remedios district of Colombia, was about 26,000 oz. of gold for the year ended June 30, 1928, as compared with about 28,000 for the preceding year. Underground work by the company was confined to the Silencio mine. A new power plant is being built on the Doña Teresa River, about six miles from the mines. It will have a capacity of 500 kva. The company has a plant in operation at Pocuné already.

In Venezuela, several gold mines are being actively exploited. Bolivar Venezuela Gold Mines has been formed, with a capital of £600,000 in £1 shares, to take over three groups of claims about 120 miles from San Felix, on the Orinoco River. The total area of the country's property is about 2,757 acres. Development work has disclosed an orebody containing about 250,000 tons of ore averaging approximately $10 a ton near the No. 4 shaft. Three winzes are now being sunk on this find. Consolidated Gold Field of Venezuela has the construction of a 500-ton plant at its properties under consideration.

The final meeting of the stockholders of Ouro Preto Gold Mines of Brazil has taken place, and the affairs of the company have been liquidated. Mine and equipment have been sold to a local syndicate, which is operating the property. This mine was for many years second only in importance among Brazilian gold mines to St. John del Rey. Operations were continued during 1928 at the latter, but details are not available.

Two groups of manganese mines in Bahia were leased for five years from Humberto de Lima by Northern & Eastern European Trading. These groups comprise fifteen mines. The agreement includes an option to purchase the mines during the time of the contract at about £40,000.

Itabira Ore has signed an agreement with the Brazilian government whereby it agrees to mine 3,000,000 tons of iron ore annually from deposits in Minas Geraes. The contract calls for smelting of at least 5 per cent of the total in Brazil.

American Smelting & Refining took an option on the Concordia property, near Salta, Argentina, and proceeded to unwater the mine. Results of examination were such, however, that the option was relinquished. The lead production from National Lead properties in Argentina will be about 4,600 metric tons, according to the last available estimate.

This review should indicate, if only in a fragmentary and rather haphazard manner, the tremendous part played by technical knowledge and careful management in the expansion of the South American mining industry. It is no longer a matter of high-grade, easily accessible operations, profits from which filled the pockets of foreign financiers in the nineteenth century. Today the bulk of the output comes from six or seven large-scale, low-grade deposits which have been made profitable as the result of painstaking research. Courage as well as capital was needed for their development.

Central America

By Charles Butters

NO NEW mining operation was begun in Guatemala in 1928, the one successful dredging operation carried on having been started three years ago. Connection of the International Railroad from Salvador via Zacapa, which is on the main line from Gautemala City, to Puerto Barrios, has been completed. One can now take the steamer at New Orleans, reach the Guatemala port in three days, and travel by train the next day to San Salvador on a daylight run. Leaving San Salvador on the following day by train, San Miguel and La Union can be reached in twelve hours. These facilities place the mines in Salvador within five or six days of New Orleans, as compared with 13 to 14 days by steamer from New York via Panama. The new connection line will aid materially in the development of certain lead and zinc deposits in Guatemala, and also provide means of transport to an unexplored mineral field in Salvador.

Considerable activity prevailed during 1928 in the mining region adjacent to San Miguel, Salvador. Central American Mines, a New York company financed by New York and Canadian capital, has undertaken systematic development of this zone. In addition to its own properties, the company has a half interest in the properties of Butters Salvador Mines, which are being developed.

In Honduras, famous in the past as a mining state, no new developments were recorded during 1928. The New York & Honduras Rosario mine continues to be the one great mining operation in all Central America; it has been successfully operated for 40 years. In any but strong, capable hands it would have been closed long ago, but constant scientific development maintains adequate ore reserves from year to year.

Nicaragua experienced a year of pacification at the hands of the U. S. Marines in 1928, and now that the elections have been held and the Liberals are in power, peace and prosperity should prevail. Most of the mines are closed, but during 1929 considerable interest will undoubtedly be taken in the gold mines of the state. Nicaragua has larger and more widely spread gold deposits than any other Central American state. The Babilonia property, once extensively operated by an English company and now in the hands of John M. Nicol, was successfully operated with arrastras by William Hanna in 1927, and will probably be equipped with a new mill. The San Albino mine, owned by me, is now a permanent marine base and hospital. Creditors obtained control of the Chontales mine, upon which two million dollars was spent, but they were unsuccessful in operating the property. The La Luz & Los Angeles property, which contains the largest developed orebody in Central America, was wrecked, as was the Bonanza; U. S. marines unfortunately arrived too late at these properties to prevent their destruction.

With the exception of Nicaragua, Costa Rica is possibly the best potential gold-mining section in Central America. Conditions are secure for property. The country deserves careful prospecting.

Owing to the new interest in mining generally, and in view of the good will of President-Elect Hoover toward Latin America, I predict increased mining activity in Central America during 1929.

Cuba

By J. C. Porter

MATAHAMBRE, in the Pinar del Rio Province of Cuba, continued to be the only steady copper producer on the island during 1928. About 320,000 tons of ore was mined, and 65,000 tons of high-grade ore and concentrates shipped. In order to increase output, Matahambre is sinking a new shaft, which, with the one now operating, will enable the company to more than double its shipments during 1929. About 125,000 tons of ore is now developed, the average grade of which is probably a trifle higher than that developed in previous years. The company is also doing exploratory work on a near-by property, Loma del Mono, which other interests have prospected by diamond drilling without success. The Matahambre company intends to sink a prospect shaft.

A German syndicate has attempted to lease or purchase the soft iron (limonite-hematite) deposits in Oriente Province that are still in the hands of Cuban owners. This action, coupled with interest in the district on the part of capital from the United States, has stirred up rumors and activities in this field. By the end of 1929 the vast iron deposits of Cuba will probably be held entirely by foreign organizations.

The first iron-ore deposits (hematite) to be mined in Cuba were those of Firmeza, from which shipments began in 1884. During 1928 about 290,000 tons of ore were mined from Firmeza and Daiquirí by the Bethlehem Steel Company. Shipments from Daiquirí were about 385,000 tons, which came from the mines of Daiquirí and Firmeza, as well as from the Daiquirí stockpile. The soft-ore mines of the north coast of Oriente Province were worked by Bethlehem Steel from January 1 to April 1, 1928. About 222,720 gross tons of raw ore and 128,244 tons of nodulized ore were produced from the mines near Felton, on Nipe Bay. Shipments to Sparrows Point, Md., aggregated about 49,000 tons of nodulized and 6,649 tons of raw ore. At the other end of the island, in Pinar del Rio Province, renewed interest was shown in the iron of the north coast by American interests. These are hematite deposits of high quality but apparently of small tonnage. An effort, however, is to be made to prove these to be of economic importance.

Bethlehem Steel shipped 3,047 tons of chrome ore from Felton that was mined several years ago and held in a stockpile at the Caledonia mine, near Mayarí. No mining was done during 1928. From the Camaguey deposits Bethlehem Steel mined 22,500 tons. Shipments totaled 25,000 tons, of which 2,500 tons was from old stockpiles. These shipments were made from Puerto Tarafa, on the north coast, to Sparrows Point.

From Chambers, in Camaguey Province, and from Mariel, near Havana, a little more than 3,000 tons of asphalt was exported; most of this went to English ports. Many times this amount was mined for local use as road surfacing.

Shipments of manganese during 1928 were small and were made mostly from Oriente. A plant for concentrating the abundant low-grade manganese of Oriente is to be constructed at Cristo, near Santiago, by northern interests. Extensive tests have been made, and a method has been discovered to handle these ores. According to reports from Santiago, this plant will be completed during 1929.

South Africa

By Owen Letcher

THE year 1928 was not a period of unqualified success and progress, so far as the Rand was concerned. Excluding diamonds, the value of the total mineral output of South Africa in the first nine months of the year amounted to £36,950,000. Mines of the Witwatersrand continued to produce gold to the value of £3,500,000 a month or about 85 per cent of the total; so, although the production of copper, asbestos, platinum, and other minerals increased, gold still held first place in the Union's mineral industries. Even though production was maintained on the usual huge scale and another record gold harvest was made, costs tended to rise and profits to contract.

A disturbing factor throughout the year was the insecurity of native labor supply. The new convention with Portuguese East Africa resulted in Transvaal mines employing native labor under less favorable terms than previously. Moreover, a gradual decrease in the numbers of the natives from Mozambique was arranged. Although present sources of supply offer little opportunity of relieving the shortage of labor, this can be achieved if the Union government will relax present restric-

tions and permit the mines to widen the recruiting area. Much attention is now accordingly being given the labor-producing possibilities of new recruiting zones and at the same time the technical staffs of group head offices, and of individual mines, are investigating labor-saving appliances and devices.

Shareholders in Kafirs suffered some rude shocks during the last few months, and the most crippling of these blows was not dealt by purely speculative concerns, but by certain of the better class of the so-called speculative investments and by one or two of the leading investments. Depreciation affected the great outlying mine of the Rand, the Sub Nigel, to the extent of nearly £2 per share during recent months. The biggest dividend payer of the Far East Rand, the New Modder, despite its 9,000,000 tons of high-grade ore in reserve, suffered a market depreciation of £2,800,000 since early in 1927. Recently annual reports of both these mines exhibit some contraction of ore reserves. Coming to the Central Rand, the decline in City Deeps from 32s. to 13s. during the last twelve months has been another serious matter and the contraction in Robinson Deep A's and B's has given a further dismal aspect to the deeper Rand. At both these undertakings development exposures have been less satisfactory than in the previous year.

During all the depreciation in Rand shares that has taken place recently, only Luipaardsvlei Estates shares, long despised, exhibited any really substantial advance. These improved 25 per cent, and, considering the marked change in the company's fortunes from the recording of losses to the earning of nearly £5,000 per month in profits, and the high percentage of payability secured in development, the generally improved outlook for the venture as exhibited by the rise in the price of the shares can easily be understood.

Definite information concerning the diamond industry of the Union is difficult to obtain. Toward the end of 1927 the government decided to suspend monthly publication of diamond returns. In explanation of this decision announcement was made that compilation and publication of these statistics involved the expenditure of more funds than the figures justified. Subsequently a statement was issued that the chief reason for withholding publication was that in the interests of an industry marketing a highly competitive product suspension of periodical statements as to production and sales was advisable. At the end of October, however, publication of diamond statistics was resumed for the Transvaal alluvial fields only.

Since the middle of 1928, the government worked the rich state diggings near Alexander Bay, on the northern Namaqualand coast. Details of these operations and their results were not revealed, but it became known that diamonds of remarkable purity, estimated to be worth as much as £6,000,000 in the aggregate, had been recovered by Oct. 1. Government airplanes transported the diamonds to Cape Town, where they were deposited in the safes of the state diamond department. Other features of 1928 in regard to gem mining in the Union include the beginning of operations in connection with the establishment of two diamond-cutting factories—one a state enterprise and the other a private concern—at Kimberley, and the discovery of emeralds in northern Transvaal. Output from the alluvial fields of the Western Transvaal has been declining. Further discoveries of diamond-bearing ground in Tanganyika territory were announced.

Periodically a wave of optimism sweeps over the platinum industry because of local advances in the study of the metallurgy of platinum and its associated metals. In the early part of last September Central Mining-Rand Mines group officially announced that metallurgists of that organization had, after years of experiment, evolved an effective and economical method for the recovery of platinum and its associated metals from Transvaal noritic and pyroxenitic ores. Simultaneously, other methods, notably that of the Chemical & Metallurgical Corporation of England, developed to a point at which success appeared to be within sight. But the spirit of hope engendered by these announcements did not endure, inasmuch as it was almost simultaneously realized that solution of the metallurgical problem would release huge quantities of the metal present in immense tonnages of low-grade ores. A solution of marketing problems and price control are, therefore, essential in successful application of the processes developed. Sales of Transvaal platinum for the first nine months of 1928 were £185,612, as compared with £144,191 for the same period of 1927.

Continued search for asbestos appears to be revealing the presence of the mineral over a vast area of southern Africa. New finds have been reported in the Zoutpansberg and in South West Africa. Evidently the Union's asbestos production will continue to expand for many years to come. Output for 1927 was worth £343,301; for the first months of 1928 it ranged between £23,000 and £41,500 per month.

The outstanding feature of 1928 in Southern Rhodesian mining fields was the increased interest in old mines, many of which were apparently abandoned because of minor displacements of the reef, employment of unsuitable operating plants, or shortage of working capital.

Another important event was the completion of the railway line to the Shabanie asbestos fields and the increases effected in the plant of Rhodesia & General Asbestos, which will increase the productive capacity of the company to more than 2,000 tons of chrysotile fiber per month. Gold output of Southern Rhodesia during the first nine months of 1928 amounted to 440,579 oz., and it was estimated that gold production of the colony for 1928 will show an increase of about 3,500 oz. as compared with 1927.

In Northern Rhodesia development of the base-metal belt immediately south of the Congo border continued, and excellent results attended the opening up of the Roan Antelope and N'Kana copper mines. Roan Antelope is to be equipped with a plant of 5,000 tons' capacity per day. Construction of the new branch railway from N'Dola is approaching the mine. Crushing operations began at the Motalla Hill mine of Luiri Gold Areas. Output of copper by Bwana M'Kubwa increased, and zinc from the new plant of the Broken Hill company remained at between 900 and 1,000 tons a month. This quantity is about two-thirds of the expected production, but certain additions to the plant are expected to bring this up to 1,500 tons.

The year in the Belgian Congo included a visit of their Majesties the King and Queen of the Belgians, who undertook the longest pilgrimage ever made by reigning European monarchs. The object of the royal visit was to open officially the Bas Congo line from Bukama to Port Francqui. Completion of the Bas Congo link with the navigable reaches of the lower river is of great importance to the mineral industry. Significant of the change taking place in the transportation systems of the Congo is that the first shipment of copper via the West Coast route, which amounted to about 800 tons, was made over the new railway line during the period of the royal visit. Another event of 1928, also of considerable importance to the mineral industry, was the completion of the Benguela Railway to the newly delimited frontier of Angola and the Congo Belge. This railway from Lobito Bay to the copper belt will probably be completed during 1930. Two routes for the export of copper and the importation of supplies by the Atlantic seaboard will then be available.

Japan and Manchuria

By Hironao Nishihara

MINING in the Japanese Empire during the first seven months of 1928 proceeded steadily and was practically unchanged from that of 1927. Japan produced during the eight months' period from January to August inclusive 202,022 oz. of gold, 2,932,032 oz. of silver, 79,453,758 lb. of copper, 37,492 tons of sulphur, and about 867,000 barrels of petroleum.

In Manchuria, the open pit at the Fushun Colliery was developed extensively, and for the twelve months' period from September, 1927, to August, 1928, produced 6,693,927 tons, or on a monthly

average of 557,829 tons. Construction of the plant for the extraction of shale oil from the overlying shale was completed following a year's experimentation. Beginning in October, 1929, it is expected that the plant will be treating 4,000 tons of shale daily, and that production will be at the rate of 50,000 tons of shale oil a year. Anshan Iron Works during the twelve months' period from September, 1927, to August, 1928, produced 206,258 tons pig iron. Additional equipment was installed at the plant to meet requirements for an increased annual production of 220,000 tons of pig iron in 1929.

Europe, Siberia, Far East, and India

By Donald J. Farquharson

MINING in the United Kingdom during 1928 continued to be confined mainly to lode tin operations in Cornwall, and the fall in the metal price during the year made the position of many of the mines rather precarious. Several of the older properties, including Tresavean, closed down, and Dolcoath was threatened with a similar fate. Recent developments at this property have been promising, but funds became exhausted, and, unless the recent appeal for £40,000 of debentures is granted, liquidation must follow. South Crofty passed its interim dividend owing to the fall in tin; other mines increased production to maintain profits. East Pool began opening up good ground, and Geevor continued to work at a profit. The low price of arsenic was another adverse factor, for the output of this byproduct could have been considerably increased if the demand had improved. Cornish tin producers are anxious to have the price of the metal stabilized at between £250 and £300 per ton, which to them would be amply remunerative. They suggest this be brought about by the prosperous alluvial mines temporarily reducing their outputs.

Low prices for lead were responsible for the closing down of the Mill Close mine, in Derbyshire, after 70 years of continuous operation. This property has produced one-third of the total lead output of the British Isles. In Scotland, development at the Leadhills mines was disappointing. A new company, Eagle Lead, was formed to work four mines in North Wales, and its Pandora mine, after being unwatered, disclosed 67,000 tons of ore averaging 7 per cent lead and 12 per cent zinc. A differential flotation plant is nearing completion, and production is due to start early in 1929. Mona Copper, another new company, took over a group of copper mines worked many years ago by "the ancients."

In Spain, the operations of the Rio Tinto company continued to expand. The Huelva pyrites deposit is diminishing in copper content at depth, averaging about 1.5 per cent at 350 meters, as compared with 4 per cent above 100 meters. On the termination of the European Pyrities Producers' Association, Rio Tinto entered an agreement with the Tharsis, Orkla, and other companies, including Mason and Barry. Yearly output of about 200,000 tons of pyrites from the Portuguese mines of the last-named company is thereby assured a market over a number of years. Extensive sulphur deposits in Almeria, together with tin and lead-silver-antimony properties elsewhere in Spain, were actively developed by the Tigon Mining & Finance Corporation, formed during 1928. Peña Copper Company's mine was reorganized and re-equipped, and production increased. Output of the Huelva Copper Company was normal.

European lead producers sustained substantial losses owing to decline in metal prices. Spanish mines reached an agreement through government intervention whereby the richer mines subsidize the unremunerative properties. These interests were, therefore, excluded from the World Lead Producers' Conference held in London in September. Low metal prices and the rise in the peseta troubled the Peñarroya Company, but dividends were maintained owing to increased production. This company's subsidiaries in Tunis and Morocco continued to develop commercial ore. The Tunis reduction plant treated by flotation the lead-zinc ores from the Franco-Tunisienne's concessions, where, in addition to excellent zinc deposits, bornite carrying 10 to 35 per cent copper was discovered. Another French company operating lead-zinc properties in Tunis, the Exploitations Minières de Tunisie, increased its capital from 12 to 24 million francs, and is to use the Coley zinc process, in which considerable British capital is interested.

Villemagne Company of France, controlled by the Russo-Asiatic Consolidated, started operations at its new 500-ton treatment plant. Mining costs were considerably reduced, and the ore treated monthly was increased from 5,870 tons in January to 11,000 tons in October. Production of zinc concentrates likewise mounted from 590 to 900 tons, and that of lead concentrates from 180 to 320 tons during the ten-month interval. Production at the Polish zinc mines was on an increased scale as compared with 1927. Silesian producers began the installation of a plant at Danzig, that will employ a new Belgian zinc process known as the "super grillage." The flotation process adopted last year at the Bulgarian mines of the Platnitzka (French) Company proved so successful that two further units are to be added. Production of lead, zinc, and copper will thereby be increased. The same company acquired interests in tin deposits in Salamanca, Spain, and a two-year option over lead mines in Almaden, Spain, that are to be actively exploited.

Mines de Bor continued to work opencast their Serbian copper deposits, increasing their output and maintaining their dividend. Another French company acquired antimony properties in the country, and the Anglo-Serbian Mining Company was formed in London to operate in southern Serbia. The Bauxite Trust obtained a renewal of its concessions in Rumania, and began the erection of an aluminum refinery at Varpalota. It is negotiating with the aluminum cartel for an increased output quota. Italy survived the critical period following the stabilization of the lira, but the mines suffered considerably. Libiola copper mines, for instance, encountered heavy competition from imported ores.

The Italian government, which controls the mercury mines of Idria, formerly under Austrian control, and the Spanish government, controlling the Almaden mines, signed a ten-year joint agreement whereby output will be restricted until accumulated mercury stocks are absorbed. A joint selling agency was also established to accelerate disposal of stocks. At £23 a flask, Almaden can make a profit of £8 or more, but Idrian conditions are less favorable. As Spain and Italy produce 85 per cent of the world's mercury, this agreement practically results in the formation of a monopoly.

Tin mining outside of Cornwall was centered almost entirely in Portugal, where both British and French capital is invested. No outstanding discoveries or developments occurred during 1928. The French Silleda company expects to produce tin concentrates soon at the rate of 150 tons a year and also 240 tons of wolfram concentrates. The company has ten years' reserves at this rate of production. The British Beralt Tin & Wolfram Company continued developing its Portugal properties and began the erection of a mill.

Russia remained enshrouded in obscurity, and definite conclusions were difficult to reach regarding the Soviet attitude toward foreign capital and foreign effort employed in developing the country's undoubtedly rich mineral resources. Views expressed on the subject during the year are contradictory. The Harriman interests relinquished their Caucasian manganese concession; Russo-Asiatic Consolidated's claim of £56,000,000 for confiscation of its properties remained lodged with the British Foreign Office, and then came the statement from the chairman of Lena Goldfields that "nothing could be more expressive of our harmonious relations (with the Soviet) than the fact that the Soviet government has consented to

stabilize its loan (of £377,583, subsequently increased) to us for a period of three years, and it is the experience of the treatment which we have received at their hands which induces us to look on our enterprise with every confidence in the future." Clearly the Soviet has not evolved a definite policy to which it will pledge adherence, although a resolution was passed in September formulating new concession laws.

After starting the year with an increased rate of export of manganese, and after opening ferromanganese works at Poti, the Harriman interests decided in May to abandon their Caucasian concession. This action was due to difficult labor conditions, coupled with unexpected competition from the subsidized state mines of Nikopol, Ukraine. For the eight months up to May, the Georgian Manganese Company exported 163,000 tons of ore, compared with 577,000 tons during the preceding twelve months. The company's mines at Tchiaturi were thereupon taken over by a Soviet trust, and the Harriman group received 7 per cent fifteen-year bonds for $3,450,000 in return for capital expended. Under Soviet control, the Tchiaturi mines exported 23,360 tons in August, but the rate dropped to 5,400 tons for the first half of October. Negotiations were then begun between the Soviet and the Société Industrielle et Internationale Fabogan for the transfer of the concessions to that syndicate, which was formed in Paris with a capital of 16½ million francs by the French, Belgian, and German pre-revolution concessionaires.

The Tetiuhe Mining Corporation reported continuation of friendly relations with the Soviet, and the signing of an agreement with the government whereby the company is to erect a large smelter, receiving in return a reduction in royalties, relief in customs duties, and unrestricted employment of a foreign technical staff. Mine development was concentrated on the opening up of a new level, where ore equal to that in the level above had been encountered. The second unit of the flotation mill, which will bring the capacity to 100,000 tons a year, had not been placed in operation, and the tonnage treated for the first nine months of 1928 was 38,724. A production of 10,764 tons of zinc concentrates and 5,871 tons of lead concentrates was made. Erection of the smelter is to start in 1929.

Lena Goldfields, as a result of continued good relations with the Soviet, and facilitated by long-term credits from the Deutsche Bank of Berlin, and other contractors, adopted an extensive development program. At the Lenskoie mines the rich drifting ground was let out on tribute, and a dredge was placed in position to start on the dredging area when the thaw comes. About 110,000,000 cu.yd. having a gold content valued at more than £8,000,000, has been proved. Three additional smaller dredges will probably be employed. In the Urals concession £500,000 has been spent on the renovation of the Revda steel works, and this plant, with the Seversky iron works, which should start up in September of 1929, should have a joint capacity of 100,000 tons a year. Ore for the two plants will be supplied from the company's Sissert mines, which are being equipped accordingly. The Degtiarsky copper mines, containing 6,000,000 tons of 2½ per cent copper pyritic ore, were developed so that 500,000 tons a year will be treated early in 1929 in a plant now being erected, and a production of 3,600 tons of copper during the year. Orders are to be placed for a large power station and three more concentrating units that will bring the 1930 output capacity to 12,000 tons of copper. The company has also placed orders through the Deutsche Bank for plant to equip the Zerianovsk and two other mines in the Altai Concession. By 1930 production at the former is estimated at 9,000 tons of lead, 1,800 tons of copper, 900,000 oz. of silver and 16,000 oz. of gold. Pending a decision of the most suitable method of treatment, zinc tonnages have not been estimated.

Development of the Burma Corporation's Bawdwin mine, in Upper Burma, was continued during 1928, below the Tiger Tunnel level, and both the Shan and Chinaman orebodies were crosscut at the 8 and 9 levels with satisfactory results. Progress was also made in the reclamation of the Chinaman orebody within the fire area. This made possible the mining of an increased proportion of better-grade ore. For the first nine months of 1928, 322,772 tons was mined and 251,830 tons was milled that assayed 21 oz. of silver, 23 per cent of lead, and 16 per cent of zinc. Production consisted of 54,200 tons of refined lead, 5,257,222 oz. of silver, and 47,680 tons of zinc concentrates. Despite the increased scale of mining and production, estimates of working profit were lower, owing to the fall in metal prices.

A new flotation plant at the Great Nurupi mine, in Korea, belonging to the Chosen Syndicate, improved results there, and record tonnages were milled. For the first nine months of 1928, 73,100 tons was treated at a working profit of £25,984. Value per ton of the gold ore crushed was about 27s., and working costs were 20s. The mine, which is developed to the 13 level, will be connected early in 1929 with an electrical power station 98 miles distant as a result of an arrangement reached with the Shimada Syndicate and guaranteed by the Chosen Denki Kabushiki Kaisha. This is expected to assist greatly in the extension of operations. Ore reserves are estimated at 187,750 tons, valued at 8 dwt. of gold a ton. Active reconnaissance and mapping of the syndicate's northern and southern concessions, to locate additional deposits, was continued during the year.

Capital employed in mining ventures in Indo-China is mostly French, and recent legislation with regard to the granting of concessions there to foreign interests will make the entry of foreign capital more difficult than heretofore. The Société Minière et Metallurgique increased its zinc output as a result of the installation of a new plant with a capacity of 4,000 to 6,000 tons of metal a year at the Quang Yen property. Prospecting of new areas was continued by the company. Most of the other companies were engaged in developing tin concessions, and large areas of 1 per cent ore are said to have been found on several concessions. British capital is interested in a 20 per cent participation held by Tanganyika Goldfields in a private syndicate formed in Paris early in 1928. This company has obtained, and is now exploring, 1,000 square miles of concessions.

Tin production from the mines of the Far East was on an increased scale, and total shipments from Malay for the first ten months of 1928 totaled 51,166 tons of metal, as compared with 42,557 tons for the same ten months of 1927. Properties having modern equipment increased outputs so as to maintain profits at lower metal prices, and Straits Settlements production was as a result about 20 per cent higher than that of last year, whereas that of the Dutch East Indies declined slightly. Output of Chinese-owned mines, which was formerly about 2,500 tons of tin a month, declined in mid-year when tin prices made mining at these expensively and crudely worked properties unremunerative. Several new dredges were placed in operation, the average number working in the Straits, Siam, and Burma during the year being 100, with more than 30 more under construction, and an equal number on order. Production should consequently continue to increase in 1929. Considerable capital has been forthcoming in London during 1928 for the development of Eastern tin mining, and a £2,000,000 company, the London Malayan Tin Trust, was successfully floated under Anglo-Oriental auspices to consolidate sixteen associated companies in Malaya. Prospecting was energetically continued throughout the Eastern fields, especially in Lower Burma, but no finds of importance were reported. Tavoy Prospectors, for instance, examined and rejected during 1928 over a dozen areas in this region alone. The Toyo tin mine, in Japan, one of the few lode mines in the East, was developed and electrified, and is being equipped with a concentrating plant to treat 6,000 tons per month. Reserves have been proved for seven years' operations at this rate.

Extensive diamond drilling programs were carried out in India by the five mines in the Kolar goldfield—the Mysore, Champion Reef, Ooregum, Nundydroog, and Balaghat. Reserves

were, in general, maintained. Mysore, which has produced £25,000,000 of gold and distributed over £10,000,000 in dividends during 43 years, appeared to have passed a persistent impoverished zone, as ore of improved grade was encountered, according to reports, at depth in one section of the mine.

Champion Reef increased its rate of development and mining, but not to the extent anticipated. At Ooregum, where 150,000 tons of 12.77 dwt. ore was milled in 1927, the rate of output was reduced to allow new rock-breaking and ground-supporting methods to be tried out. These are necessary owing to the increased length of the oreshoots in the lower levels of the mine. The milling plant was increased to treat the old sand dumps, and recoveries from these partly counterbalanced the reduction in mine tonnage. Values continued in the deeper development on the 69 and 70 levels. At Nundydroog promising oreshoots were encountered in the East and South sections. These added considerable tonnage of high-grade ore to reserves. Average monthly gold returns, which were 5,803 oz. in 1927, improved to 6,248 oz. for the first ten months of 1928. Balaghat developed the northerly extension of the rich Nundydroog oreshoots with good results. More than 9,000 of the people of the region were employed underground in the Kolar field.

Progress in the erection of the treatment plant at the properties of the Indian Copper Corporation was satisfactory, and operations are expected to start soon. The mill has a capacity of 100,000 tons a year, and is connected to the Mosamboni mine by a 5-mile aërial ropeway. Work at the mine consisted in blocking out the known oreshoots preparatory to stoping. This work developed 597,466 tons of 3.94 per cent copper ore. The Indian import tax should make possible for the corporation a satisfactory price for its output. Owing to a strike of three months' duration at the Jamshedpur works of the Tata Iron & Steel Company, production at the mines was reduced during the year, and the company was not able to declare the dividend expected in the first year the new protection régime was in force.

The Hyderabad (Deccan) Company, which spent over £300,000 before the war in the search for precious minerals, subsequently turned its attention to the Singareni coal areas, where production increased. The company recently obtained leases over garnet and corundum areas at Khammamett, where operations are expected to start early in 1929.

A new company, the East India Manganese, was formed in London with a capital of £140,000 to acquire certain manganese fields situated in Bihar and Orissa. A discovery of gold was reported from Afghanistan, but no details were available.

Australasia

By Peter G. Tait

NO development of outstanding importance in Australasia can be recorded for 1928. If results be summarized, the most that can be said is that the mining industry is holding its own and endeavoring to adjust itself to economic conditions. Indications are that 1929 will show real progress.

Advance figures indicate that the 1928 output of gold will not be much below that of 1927, when 630,914 oz. was produced in Australasia, the Dominion of New Zealand being responsible for 118,830 oz. The gold-mining industry has been more directly affected by high costs than any other branch of mining, but grounds for optimism in regard to the future are evident, particularly in Western Australia. The Golden Mile, at Kalgoorlie, has given proof that further production may be expected. Favorable developments were reported in the Chaffers mine of the Lake View and Star group, and the old Boulder No. 1 has been taken over by an Australian company known as the Enterprise G. M. Co. South Kalgurli is the only company paying regular dividends. Great Boulder, Boulder Perseverance and Associated mines are all being operated at a profit. A report on the Golden Horseshoe has been prepared and expectations are that the reconstructed company will soon reopen the mine. J. W. Sutherland, general manager, has developed an improved method of treatment, utilizing bromocyanide. Rumors of an amalgamation of the several companies have ceased, for the present at least.

Reopening of Wiluna mines, which will be equipped with a large treatment plant during 1929, indicates that the resources of the continent are not by any means exhausted. Further afield, in New Guinea, 1929 may be expected to determine the future prospects of gold mining there. A London company has an option on several leases, and, if the option is exercised, a considerable sum of money will be expended. Regular shipments of alluvial gold are being made, but the future depends on uncovering the reefs which have been the source of the gold.

Mount Lyell was the only copper company producing in 1928. The tunnel connecting the North Lyell mine with the smelter was completed. This will considerably reduce pumping and haulage costs. The new electrolytic refinery is in operation, and will also aid in the reduction of production costs. Previously, the blister copper was sent to a refinery in New South Wales, but the saving in costs by refining at Queenstown will soon pay for the capital expenditure involved in constructing the refinery.

Tributers and "gougers" on the Cloncurry field, in Queensland, are steadily shipping high-grade ore, either to New South Wales or to overseas smelters. Hampden-Cloncurry Copper, which operated on a large scale in this district, has liquidated and ceased all operations in the field. Mount Elliott is said to have raised £400,000 to finance a resumption of operations. One unit of the Mackay electro-chemical plant was erected several years ago, but has not been given an operation test. New plant and equipment to treat 200 tons of ore daily from the Mount Oxide mine will be provided, and the Hampden Consols, Dobbyn, and Orphan mines will be reopened. Ore from the mines will be concentrated and smelted at Cloncurry; an electrolytic refinery may also be built.

The Broken Hill lead-silver-zinc district was seriously affected by the drop in metal prices, but the three large mines, the North, South, and Zinc Corporation, together with the Central, were able to maintain operations notwithstanding high wages and the 35-hour week. Improved recoveries and the introduction of new plant counterbalanced to some extent the lower prices. Another step leading to considerable economies is the proposal to construct a central electrical generating plant powered by crude-oil engines. Each of the companies at present has its own power plant. Coal used is shipped by boat from Newcastle to Port Pirie, whence it is transported by rail to Broken Hill. Its cost delivered is 63s. 9d. per ton. Moreover, the uncertainty of coal supply, owing to the frequency of shipping and coal strikes, is an important factor.

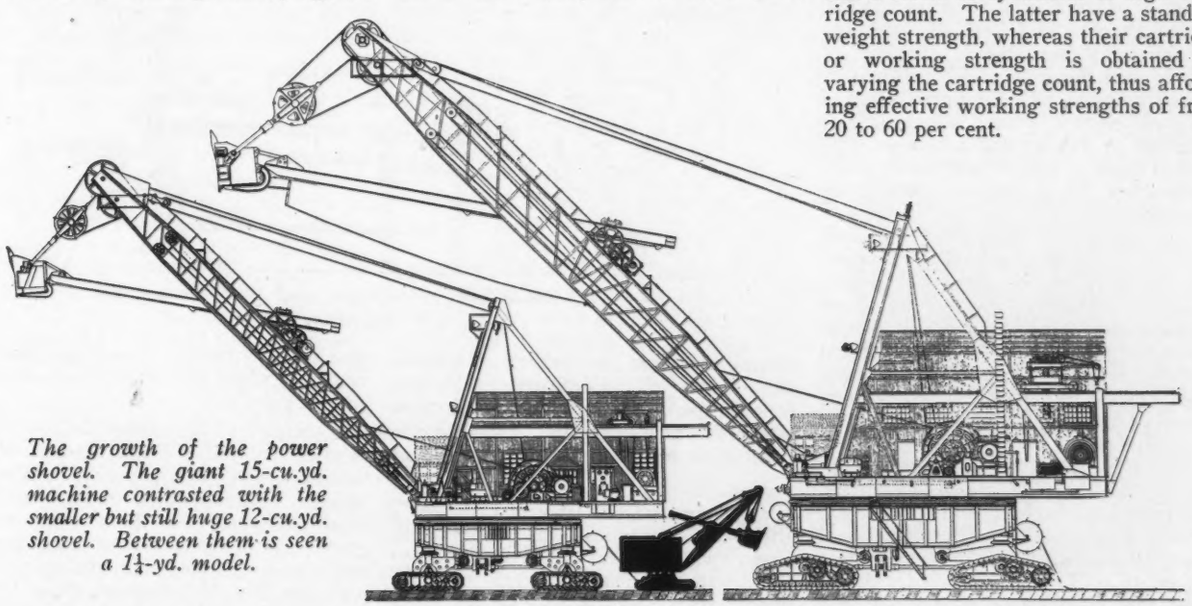
Output of the Broken Hill mines, despite the closing down of several properties, should be only slightly less in 1928 than during 1927, when 1,394,926 tons was treated. Lead concentrates, as in previous years, were sent to the Port Pirie smelting works, and the zinc concentrates to the Electrolytic Zinc Company. This company, which controls a group of mines on the west coast of Tasmania, is erecting at Rosebery a mill to have a capacity of 150,000 tons a year. The ore is a zinc sulphide containing 25 to 30 per cent zinc, 6 to 7 per cent lead, 7 oz. of silver a ton, and several pennyweights of gold.

Petroleum occurs in the natural state in Australia. This has been proved by boring at Roma, in Queensland; on the Kimberley field, in Western Australia; and at Lakes Entrance, in Victoria. Whether the oil occurs in commercial quantities is a question, the answer to which may be obtained in 1929. Taranaki and other companies in New Zealand are pursuing their boring policy, and, though the results have not been all that was hoped for, experience testifies that oil does occur in the Dominion. Several companies are also boring in Papua and New Guinea.

Industrial Progress

Developments Mark Many Equipment Lines

IN THE development of process and equipment is to be found a reliable index of industrial progress. Elsewhere in this issue the innovations made during 1928 in methods of mining and treating ore are duly chronicled. It remains to tell of the service rendered the operator by the manufacturer of equipment in developing new and improved machines with which it is possible to better results and lower costs. Though in the aggregate the amount of new equipment introduced was large, in only a few lines were the developments sufficiently notable to be termed outstanding. These latter included power shovels, classifiers and thickeners, and, to a lesser extent, crushing, conveying, and pumping. In the following each class of equipment will be considered separately.



The growth of the power shovel. The giant 15-cu.yd. machine contrasted with the smaller but still huge 12-cu.yd. shovel. Between them is seen a 1¼-yd. model.

Machine Drills — Rock-drill design continued in 1928 its trend toward light, fast, powerful machines having no projecting parts. Ingersoll-Rand produced three new jackhammers, weighing 43, 57, and 72 lb. respectively, in which emphasis was placed on the elimination of the valve chest on the side of the cylinder and certain other features. That company also introduced three new drifter drills, of streamline body and differing only in size, the weights being respectively 114, 138, and 185 lb. These machines were intended for work ranging from heavy duty in hard rock to drilling in medium soft ground or in close quarters. They have the valve in the back end of the cylinder.

A 39-lb. rotator, for either dry or wet drilling, was developed by the Sullivan Machinery Company, Chicago. This machine delivers a blow of moderate strength, coupled with rapid powerful rotation, and may be mounted on a column or a tripod.

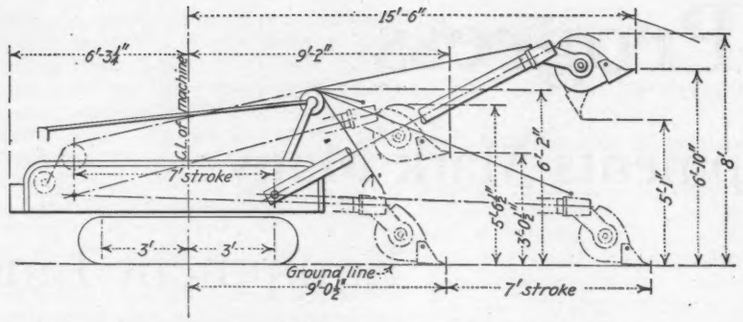
Other machines introduced included a hammer drill with a swivel hose connection, made by the Cochise Rock Drill Manufacturing Company, Los Angeles, and a light, simply-built but powerful streamline drifter, and a 48-lb. hand hammer drill for heavy work, both produced by the Cleveland Rock Drill Company, Cleveland.

In connection with drills is to be mentioned the Gilman Manufacturing Company's (East Boston) improved machine for hardening and tempering rock-drill bits. This is now provided with an electric furnace instead of an oil furnace. Likewise, a new, small-sized drill sharpener and an oil-fired drill-steel forge are to be credited to the Gardner-Denver Company, of Denver.

Churn- and core-drilling equipment included some innovations. The Sullivan Machinery Company introduced a metallic alloy having practically the same characteristics as carbon or black diamond, and which under certain conditions can be used effectively as a substitute for the latter in core-drill bits. The same company brought out a gas-engine-driven core drill, using chilled-steel shot, for testing concrete pavement and foundations.

Explosives — The trend continued toward the production of low-freezing, safer, and more economical explosives for underground use. The Hercules company introduced a new gelatine dynamite with improved fume qualities, and a series of dynamites of high cartridge count. The latter have a standard weight strength, whereas their cartridge or working strength is obtained by varying the cartridge count, thus affording effective working strengths of from 20 to 60 per cent.

Power Shovels—The remarkable advance made in power shovel design is well illustrated in the accompanying sketch. The largest of the three shovels is the Marion company's huge new 15-yd. machine, the world's largest, which was under construction in 1927 and is now being assembled. Its boom is 120 ft. long and its total weight 1,550 tons. Alongside of it is seen the Marion 12-yd. machine, with its 90-ft. boom and weighing 850 tons. Whereas the 12-yd. shovel is the logical development of the company's familiar 8-yd. (Model 350) machine, the 15-yd. shovel represents a new design throughout, its parts being strengthened in proportion to the heavier duty expected. Both are built



The overhead clearance of this electric shovel, used by the St. Joseph Lead Company, has been lowered to 6 ft. 2 in.

for electric operation and Ward Leonard control. Of the 12-yd. machines six are already in service and others being built. In contrast is shown one of the company's Model 450 shovels.

Development of two Diesel-electric shovels, of 2-cu.yd. and 1¼-cu.yd. capacity respectively, marked an advance by the Marion company in the direction of fuel economy.

Accomplishments of the Bucyrus-Erie Company, South Milwaukee, Wis., consisted in placing in quantity production a ¾-yd. gasoline or Diesel machine, convertible to either shovel, dragline, or crane; also the first 12-yd. full-revolving stripping shovel; the introduction of a 1½-yd. electric shovel, convertible to dragline or crane, and available with several types of drives; and the development of a 2½-yd. quarry shovel and dragline.

The electrical equipment of both Marion and Bucyrus shovels is designed and supplied by the General Electric Company. That for the Marion 15-yd. machine consists of a five-unit motor-generator set taking alternating current at 4,000 volts, through a 3-in. trailing cable 1,000 ft. in length. The five units consist of a motor, three generators, and an exciter.

Two changes were made in its standard lines by the Thew Shovel Company, Lorain, Ohio. It equipped its Lorain-75 shovel (1¼-yd.) with short boom and dipper stick to work in a minimum opening of 15-ft. head clearance by 25 ft. width. It also lowered the overhead clearance of its Type S mining shovel, illustrated in the sketch, to 6 ft. 2 in. The machine shown has a ½-yd. dipper.

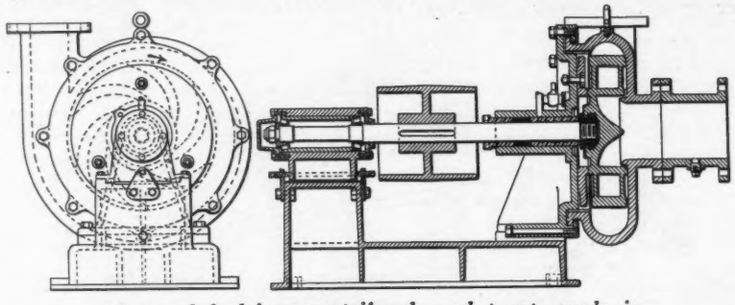
By applying a simple non-automatic shovel motion to the front end of its machine in place of the double-action automatic shovel, the Myers-Whaley Company, Knoxville, Tenn., produced a single-motion machine that has distinct advantages in handling coal and, under certain conditions, the softer rocks and ores. The Harnischfeger Corporation, of Milwaukee, introduced a 3½-yd. machine, convertible for use as shovel, dragline, or crane. Likewise, the Link-Belt Company, Chicago, brought out a 2-yd. machine, convertible either to shovel, dragline, clamshell excavator, or trench machine.

Haulage—Electrification of the haulage system of Utah Copper Company's Bingham properties was undertaken. From twenty to forty electric locomotives will be installed. Of the first twenty, two will be the 75-ton combination storage-battery, trolley and cable-reel type, such as was equipped by General Electric for the company in 1927 and given a thorough trial. The remaining eighteen will not be provided with batteries, but will take power from overhead and side-arm pantagraph trollies or from trailing cable.

A battery locomotive of high efficiency, low maintenance cost, and low first cost was introduced by the Atlas Car & Manufacturing Company, Cleveland. Of compact design and moderate weight (3,000 lb.), it can be run on any 48-in. mine cage and through the average timbered drift.

Other locomotives introduced included a 20-ton gasoline machine, built in all gages from 30 to 56½ in. and geared for four speeds, which was built by the Milwaukee Locomotive Manufacturing Company, Milwaukee, and a 60-ton Diesel locomotive made by the Fate-Root-Heath Company, Plymouth, Ohio.

Haulage accessory equipment included a new turret-type harp and pole-head casting for trolley-wheel and glider operation, introduced by the Ohio Brass Company, Mansfield, Ohio, which also brought out a safe trolley tap of simplified design. The Nordberg Manufacturing Company, Milwaukee, produced a new model of its track-shifting machine, which will move track as narrow in gage as 36 in.

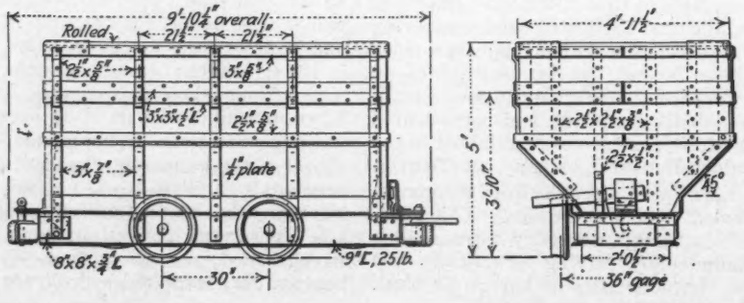


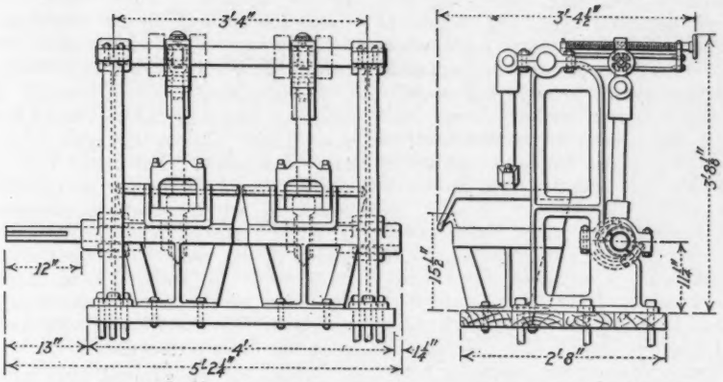
A new belt-driven centrifugal sand pump, made in 2-, 3-, 4- and 6-in. sizes

Transport—The Sanford-Day Iron Works, Knoxville, Tenn., introduced its automatic drop-bottom car to the mining industry in capacities up to railroad size. This car has a low center of gravity, is compact and strongly made, and can be dumped without labor. As built for the Birmingham Slag Company, of 40-ton capacity, it presents certain new features. Because of its hopper length, it has four doors. It also has eight wheels with brakes on all. Two have motors and a motorman's cab at one end. The car weighs 37,000 lb., is 8 ft. 3 in. above the rails, and 9 ft. 2 in. wide, and has sides 28 ft. 7½ in. long. The same company also furnished to the Nevada Consolidated Copper Company an extra heavy mine car, of 4,320 lb. weight and 96 cu.ft. capacity level full. This is shown in the illustration.

A car of 68 cu.ft. capacity and 3,450 lb. weight, and having superior features of design, was developed by the Park Utah Consolidated Mines Company for tunnel haulage. A crawler dump wagon made by the Western

An extra-heavy mine car, weighing 4,320 lb. and of 96 cu. ft. level capacity, supplied to the Nevada Consolidated Copper Company





In this diaphragm sludge pump the quantity pumped may be regulated without stoppage

Wheeled Scraper Company, Aurora, Ill., is of unusually stout construction. It is made in 5-, 7- and 10-cu.yd. sizes, for use behind a 30- or 60-hp. crawler tractor, singly or in trains of two.

Pumping—Important advances were made in automatic pumping. By reason of earlier developments Barrett, Haentjens & Company, Hazleton, Pa., were able to design automatic pumping relay panels for use with standard electrical equipment. These panels contain all of the control relays properly grouped and connected for the special work, so that the operator need concern himself only about selecting the most suitable automatic starter and the like. A number of metal-mining companies installed automatic pumping equipment.

A. R. Wilfley & Sons, Inc., Denver, introduced a 1-in. centrifugal sand pump for handling flows of 3 to 35 g.p.m. at heads up to 50 ft. This is the first heavy-duty small-size sand pump ever placed on the market. The company likewise developed split frames for 1-, 2-, 3- and 4-in. centrifugal sand pumps to meet certain acid pulp conditions and to facilitate replacement. The split frame is divided into a base and an intake chamber, only the latter of which need be cast of acid-resisting metal. The same manufacturer also developed a two-piece runner with large expellers for 1-, 2-, and 3-in. centrifugal sand pumps, where high intake heads prevail. Under such conditions the two-piece construction is of advantage in preventing leakage.

The Southwestern-Littlewood centrifugal sand pump, developed by the Southwestern Engineering Corporation, Los Angeles, has certain novel features of design which insure efficiency and permit economical first cost. Wearing parts are of hard white iron. A diaphragm sludge pump introduced by the Hardinge Company, York, Pa., permits regulation of quantity pumped without stoppage of pump. Thus no loss of static head takes place and the flow is uninterrupted. Two sand pumps, of 1½-in. and 2-in. size respectively, were introduced by the Krogh Pump and Machinery Company, San Francisco.

Five new motor-driven centrifugal pumps were produced by Goulds Pumps, Inc., Seneca Falls, N. Y. The De Laval Steam Turbine Company, Trenton, N. J., introduced a multistage centrifugal machine, the distinguishing feature of which is the use of solid, instead of split, removable diaphragms between stages, thus avoiding springing. The Nash Engineering Company, South Norwalk, Conn., brought out a single-stage self-priming centrifugal pump (the Jennings), in standard size up to 1,000 g.p.m. A portable gas-engine-driven centrifugal pumping unit with capacities up to 230 g.p.m. against a 37-ft. lift was introduced by the American Manganese Steel Company.

Hoisting—Few developments in the metal-mining industry called for unusual hoisting equipment. Miami Copper's present hoisting plant is being duplicated by the General Electric Company. The first fabricated steel-frame induction motors for mine hoisting service were also introduced, likewise by General Electric. Some new and larger sizes of portable electric hoists for various purposes were brought out by the Sullivan and Gardner-Denver companies. In the hoist-brake field the Ottumwa Iron Works, Ottumwa, Ia., was responsible for interesting new developments. These were the invention of an emergency trip device and the provision of a means of deferring the emergency application of brakes under certain conditions. A double-drum electric hoist, built by Allis-Chalmers for El Potosi Mining Company, Chihuahua, was equipped with safety appliances of the latest type; also with a new device permitting what is essentially semi-automatic control after the hoist has once been started. The same company also developed a new type of multiple-arm double-disk clutch for electric hoists.

Wood Preservation—A new timber preservative, zinc meta-arsenite, was developed in the engineering laboratories of the Western Union Telegraph Company. This is said to be as toxic, inexpensive, and permanent as the arsenites of copper, and also to be non-corrosive to iron.

Crushing and Grinding—The outstanding feature in this field was the construction of large units, in some instances larger than those formerly used. A 48-in. gyratory crusher with an all-steel frame and specially designed for a wide range of adjustment of product-size was built by the Traylor Engineering & Manufacturing Company, Allentown, Pa., for the Bethlehem Mines Corporation. The Traylor company also increased its line of reduction gyratories by adding a 15-in. and a 20-in. machine, the latter being the largest built, according to the maker. The company also developed a new safety device, shown in the cut, for guarding its jaw crusher against breakage by tramp iron. It also built an 8x16-ft. rod mill carrying a rod load of 40 tons and requiring 400 hp. It reports also a greatly widened use of its "four tension rod" roll (or Ajo type), introduced about five years ago.

A coal-pulverizing unit, developed by the Hardinge Company, embodies a principle of pulverizing by which instantaneous control of the coal issuing from the mill, as well as of that fed to the burners, is obtained. This, the company claims, represents a radical departure.

Construction of a ball mill, of 10½-ft. inside diameter and 10 ft. inside length, was undertaken for Miami Copper by the Williamson Company, of San Francisco. It will have a ball capacity greater than the proposed working charge of about 56,000 lb. of balls and

A safety device for protecting a jaw crusher against breakage by tramp iron

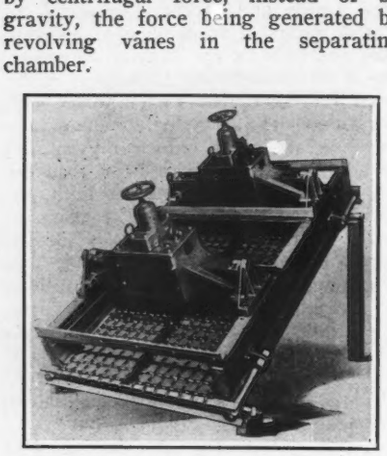
will be of the overflow-discharge type.

During 1928 the Straub Manufacturing Company, Oakland, Calif., developed its "Rib-Cone" mill and remodeled its stamp mill, reducing the number of moving parts to one, which is fitted with Timken bearings and submerged in oil. Gearing has been eliminated and power consumption reduced one-fifth.

Considerable new development work, now just culminating into final designs, was done by the Pennsylvania Crusher Company, Philadelphia. This had to do with some special single roll-crushers, some very large hammer crushers, and special feeders for serving the latter.

An improved air separator was in-

troduced by the Rubert M. Gay Company, 114 Liberty St., New York. It operates on the principle of separating by centrifugal force, instead of by gravity, the force being generated by revolving vanes in the separating chamber.



The so-called "floating" screening surface of this vibrating screen gives it a higher efficiency on coarse material

Screens—New vibrating screens and improved models of older screens came on the market. The W. S. Tyler Company, Cleveland, Ohio, developed a so-called "floating" screening surface which, it claims, gives a new kind of screening action on coarse material. The surface floats free of the body and, when caused to vibrate, does so as freely at the ends and sides as at any other point, affording an advantage where heavy loads are handled. This screen surface is shown in the cut.

The Traylor Vibrator Company, Denver, equipped its screen with a steel screening deck, replacing the previous one of maple. Deister Machine Company, Fort Wayne, Ind., turned to all-steel welded construction to improve its vibrating screen. Deister Concentrator Company, also of Fort Wayne, likewise improved its vibrating screen, developing a free-swinging screen jacket that may be easily and quickly changed. Another improved screen was that of the Cottrell Engineering Company, California.

A notable accomplishment was that of the Newark Wire Cloth Company, Newark, N. J., in producing a 400-mesh wire cloth.

Conveying—Among the outstanding developments in the conveying field was the vibrating conveyor, of both trough and tube types, developed by the Traylor Vibrator Company, of Denver. This is adaptable as a feeder for crushing and grinding and other ore-dressing equipment. It is vibrated electrically. The Vulcan Iron Works, Wilkes-Barre, Pa., developed a complete line of shaking chute conveyors, having 8-ft. sections of 12-, 16-, 18, and 24-in. widths. The driving units are built in three sizes with motors ranging from 5 to 30 hp.

Stephens-Adamson Manufacturing Company, Aurora, Ill., made important contributions, among them a so-called "frictionless" bin gate, consisting of a compact belt conveyor, the frame of which may be moved by a hand wheel back and forth under the bin opening. The same company brought out an automatic steel apron feeder, 30-in. wide and 7 ft. 6 in. between centers, carried on a traveling car and surmounted by a hopper. It is operated by a motor on the car.

The largest pan feeder known was built for the New Cornelia company by the American Manganese Steel Company, Chicago. It is 72 ft. long, 8 ft. wide and is set on an 18-deg. incline.

Still another device, the Telepoise, a new type of machine for weighing materials in transit on a conveyor, was added to the year's achievements. It is made by John Chatillon & Sons, 85 Cliff St., New York. New belt carriers and conveying idlers were produced by various manufacturers, including the Stearns Conveyor Company, Milwaukee. Another long conveyor line, 2½ miles long, for transporting coal from mine to river dock, was installed by the H. C. Frick Coke Company, in Pennsylvania.

Concentration—Advance in concentration was chiefly in flotation equipment. The Southwestern Engineering Corporation, Los Angeles, introduced an "air-lift" machine which differs from the pneumatic type in that the air comes into contact with the pulp directly from pipe ends or other orifices. It is credited with low power consumption and maintenance cost. The same company introduced a dry reagent feeder that will feed down to 10 grams of reagent per dry ton milled. The General Engineering Company, New York, improved its MacIntosh machine by adopting a slip-over sock covering for the rotor and Goodrich Cutless rubber bearings in the stuffing boxes, and by using a metal rotor. The Ruth Company, Denver, announced its so-called "Gradient" flotation machine, in which each cell is an individual unit resting on an individual foundation step, the gradient being such that the froth will flow freely. This company also brought out a new laboratory flotation machine. A new porous medium for flotation cells was devised by F. C. Dyer and H. L. McClelland, at Toronto. It will withstand abrasion and, with low air pressure, deliver a flow of air over a surface covered with water. It is a mixture of cork and oils.

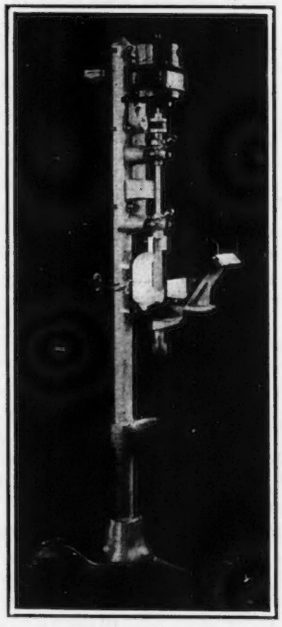
Equipment for controlling the hydrogen-ion concentration of flotation and other pulp was brought to the attention of mill men. A small flotation testing set for this purpose, using liquid color standards, was introduced by La Motte Chemical Products Company, Baltimore. Cottrell Engineering Company, Los Angeles, introduced an improved dry concentrator, using air, and a portable dry washer.

Sampling—A combination pneumatic and hydraulic sampling system was developed by the Southwestern Engineering Corporation. This includes a head or ore sampler, a pulp sampler, and a timer for controlling the movements of the pulp-sample cutters, the time element being subject to wide adjustment.

Thickeners—A 325-ft. traction thickener for handling tailing was built for the Miami Copper Company by The Dorr Company. The latter also introduced a repulper for use with its thickeners in counter-current decantation. This is a mechanical mixing unit installed in the launders between adjacent thickeners. A rather static condition prevailed as to concentrate thickeners, owing to the use of xanthate and the adoption of selective flotation.

Classifiers—In general 1928 saw unusual developments in new uses for Dorr classifiers. The Dorr Company undertook to build for the Miami Copper Company two bowl classifiers, each 20 ft. wide and 42 ft. long, with 28-ft. bowls.

Filtration—Merger of the Oliver Continuous Filter Company and the United Filters Corporation was effected, thus bringing together the two important interests in this field. The Oliver filter was equipped with a new type of screen, giving better drainage, drier cake, and



An improved laboratory flotation machine made its appearance

longer cloth life. Improvements in the drive and wiring device make it possible to re-cover and service an 8x12-ft. filter in less than three hours. In the American filter changes in construction of sections and in methods of attachment to the disks reduce the time required for changing sections. Improved methods of discharge give higher capacity. A continuous and fully automatic vacuum filter of the leaf type was introduced by the Southwestern Engineering Corporation. Every leaf is a separate unit. Change of cloth and regulation

of speed can be effected quickly. Following the development of the principle of streamline filtration by H. S. Hele-Shaw, a rotary filter embodying the principle was introduced by Dr. Hele-Shaw and his associates.

Furnaces—By providing, in the hollow central shaft of the Wedge furnace, four ducts which serve to carry cooling air to the rabble arms and to convey exhaust air away from them, the Bethlehem Foundry & Machine Company (Bethlehem, Pa.) was able to eliminate the large number of individual pipes formerly used within the shaft, and thereby to improve the air-circulating system of the furnace and to allow more space within the shaft for workmen to enter and manipulate the arm-locking devices, when necessary. A new scheme of firing Wedge furnaces was developed by the Mahr Manufacturing Company, of Minneapolis, for the Sullivan Mining Company. Mahr low-pressure burners and individual direct-connected motor driven blowers were used.

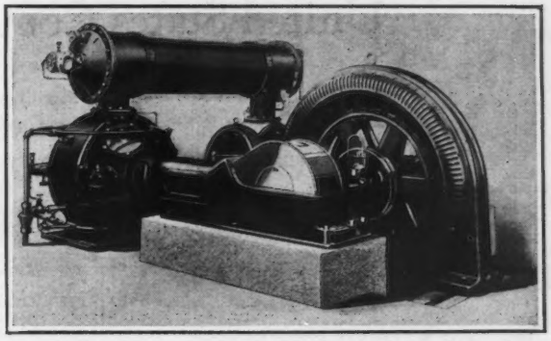
Blaw-Knox Company, Pittsburgh, developed an improved hoisting scheme for operating the doors of open-hearth and other furnaces. A single motor is required. Construction of a new type of rotary quicksilver furnace was begun by the Cottrell Engineering Company, Los Angeles.

Refractories—Important research was conducted in 1928 with the object of developing new refractories. Specific new products included a brick highly resistant to acid attack, introduced by General Refractories Company, Philadelphia; a ladle nozzle the upper half of which is super-refractory clay and the lower half graphite, this being made by the Dixon Crucible Company; also a new cement gun for maintaining refractory surfaces, made by S. Obermayer Company, Chicago.

Leaching—The United Filters Corporation devised a quick-opening manhole cover for use on the ammonia stills of the Calumet & Hecla company.

Blowers, Fans—Anti-friction bearings were adopted for its blowers by the P. H. & F. M. Roots Company, Connersville, Ind., and the Roots blower was completely redesigned to gain every mechanical advantage possible, in particular that of better lubrication. The remodeled blower delivers more volume with less horsepower. The Connersville Blower Company improved its line of blowers and gas pumps and adopted new bearing designs including use of anti-friction bearings.

Measuring Instruments—Many new and improved models of measuring instruments appeared in 1928, including a new line of ammeters and voltmeters for service underground or under damp conditions, introduced by Westinghouse; and a weir-type flow meter, brought out by the Cochrane Corporation, Philadelphia. The Brown Instrument Company, Philadelphia, equipped its recording thermometers and pressure gages with aluminum cases. The Roots company improved its flow meter mechanically and as to operating characteristics.



Improvements made in this type of duplex compressor include raising the bed at the crank end to prevent escape of oil and provision of an oil pocket cast integral with the main frame on the outside of the crank case

Compressors—The Sullivan company, which has long used the "angle-compound" principle of design in its larger machines, developed a small compressor, of 313 to 414 cu.ft. capacity, embodying the same idea. This machine has an 8-in. stroke and is intended for pressures of 100 to 125 lb. It requires little space. Two portable mine-car-type compressors, of 106 and 230 cu.ft. capacity respectively, and intended for use where headroom is limited, were also introduced by Sullivan.

Ingersoll-Rand remodeled three of its standard medium size (676 to 1,875 cu.ft.) duplex compressors, making changes in line with the modern trend toward higher speeds, lighter inertia loads and better balance, smaller floor-space requirements, and lighter weight. An intercooler of new design, carried overhead instead of below the compressing cylinders, was develped. Improvements were also made in the familiar Class PRE (1,302 to 7,440 cu.ft.) duplex machine. The bed was raised at the crank end to prevent the escape of oil, and an oil pocket cast integral with the main frame on the outside of the crank-case was provided. New starting unloaders were designed to match the push-button control of the direct-connected synchronous driving motors. The company also introduced a direct-connected gas-engine-driven duplex machine for general service; also an improved aftercooler.

Several new air filters were introduced. Among the makers were the National Air Filter Company, Chicago; the Staynew Filter Corporation, of Rochester, N. Y.; and the Midwest Air Filters, Bradford, Pa.

Power Plant—Great progress has been made in steam generation, which is reflected only to a small extent in the metal mining industry. The practices of using higher pressures, of pulverizing coal, of conditioning water, of preheating air, and of recovering waste heat have all contributed to increased efficiency of operation, but have been adopted by operators to a varying extent, despite the variety of equipment introduced. The use of the steam accumulator for storing heat was advocated in the United States.

Various new Diesel units appeared, among them a 92-hp. light-weight, high-speed engine made by the Buda Company, also several gas engines.

A wide variety of electrical equipment, including motors, transformers and switchgear, was introduced in 1928, the contributing manufacturers including the General Electric and Westinghouse companies, in particular, and numerous others. Allis-Chalmers undertook to introduce to American operators the Reyrolle armor-clad switchgear, long familiar abroad. A means for automatically regulating power factor was developed by the Electric Controller & Manufacturing Company.

Power Transmission—A remarkable oil-filled cable for long-distance transmission of electric power was developed by the New York Edison and the United Electric Light and Power companies. It is 12 miles long, and carries 125,000 hp. at 132,000 volts, this being the highest pressure yet attained and three times the amount of energy ever transmitted through an underground cable. For mechanical transmission, various types of speed reducers and flexible couplings were introduced, the Falk Corporation, Milwaukee, in particular, making additions and refinements to its line.

Bearings—Increased use of and demand for anti-friction bearings in mining and milling equipment marked the year just past. Such bearings have become decidedly "fashionable," this being justified through the decrease in power consumption they make possible.

Lubrication—The subject of lubrication continued to receive increased attention from manufacturers and operators. Despite the widespread use of pressure fittings on certain types of machinery, such as conveyors and mine cars, however, the mining industry offers a great opportunity for the wider application of equipment of this sort, particularly with respect to lubricating from a central point.

Shop Equipment—The outstanding achievement of 1928 in the introduction of new shop equipment was the production by General Electric of a new and extremely hard and strong tool material composed of tungsten carbide and cobalt. It is known as Carboloy, and has been found 25 to 75 times as durable as high-speed tool steels in cutting low-tensile materials. Welding equipment, in various forms, continued to come on the market to meet the great demand.

United States Commerce in Ores and Metals

From U. S. Government sources

Eleven-Month periods ending with November
Figures in pounds, unless otherwise stated

I—Copper

	1927	1928
Imports		
Ore, concentrates, matte	157,062,910	131,957,739
Unrefined, black, blister	400,071,765	496,316,934
Refined	100,081,545	61,335,044
Total	657,216,220	689,609,717
Exports		
Refined	831,879,317	881,716,733
Rods	53,035,601	66,405,873
Wire	9,447,250	14,764,392
Cable and insulated copper wire	20,975,789	18,000,473
Other forms, including scrap	49,996,249	60,205,920
Total	965,334,206	1,041,093,391

II—Lead

Imports		
In ore and matte	77,018,251	45,674,261
In bullion	219,695,844	229,671,233
Pigs, bars, other forms	4,891,129	1,209,718
Scrap babbitt, lead content	1,112,479	813,850
Type metal, lead content	652,491	2,819,610
Total	303,370,194	280,188,672
Exports		
In pigs and bars—		
From domestic ore	4,465,923	21,716,334
From foreign ore	216,732,290	183,053,946
Manufactures	8,946,975	13,647,437
Total	230,145,188	218,417,717

III—Zinc

Imports		
Ore (duty paid)	18,777,412	2,812,213
Ore (duty free)	1,650	75,599
Blocks and pigs	47,787	5,651
Total	18,826,849	2,893,463
Exports		
Ore, concentrates, dross	8,425,650	5,664,739
Slabs, blocks, pigs	89,173,942	47,852,490
Sheets, strips, other forms	7,250,015	7,738,235
Zinc dust	2,440,792	1,898,119
Other zinc manufactures	2,493,048	2,004,998
Total	109,783,447	65,158,581

IV—Gold and Silver

Imports		
Gold, value	$197,104,000	$143,947,000
Silver, value	51,303,000	62,997,000
Exports		
Gold, value	$123,606,000	$559,123,000
Silver, value	68,438,000	78,882,000

V—Exports of Minor Metals and Minerals

Aluminum: Ingots, scrap	3,265,594	2,272,382
Manufactures	11,490,312	13,179,568
Nickel, metal and alloys	1,924,690	2,074,383
Platinum, oz	18,512	8,968
Tin, bars	1,853,341	714,177
Tin manufactures, value	$1,762,238	$1,403,242
Asphalt and bitumen, tons	34,082	21,683
Manufactures of, lb	57,352,017	34,777,333
Sand and gravel, tons	356,196	604,092
Cement, bbl	754,627	761,536
Fireclay, tons	39,785	48,132
Other clays, tons	42,138	49,815
Asbestos, tons	233	723
Gypsum and manufactures	34,614,153	29,742,705
Mica and manufactures	2,725,503	3,240,166
Sulphur, tons	733,056	654,082
Salt, lb	288,515,322	260,345,720
Graphite and manufactures, except crucibles	3,361,722	4,188,477
Phosphate, tons: High grade hard rock	127,129	86,307
Sand pebble and other phosphate rock	734,796	763,041
Borax	66,805,686	129,833,099
Ocher, umber, sienna, whiting, lb	34,839,306	35,472,734
Magnesia and manufactures	5,203,057	5,484,169

VI—Imports of Minor Metals and Ores

Aluminum, metal, scrap and alloy	63,265,298	35,701,085
Antimony in ore	3,631,343	3,145,049
Metal	23,238,306	19,741,665
Cobalt	453,412	549,501
Platinum, oz	118,827	98,974
Iridium, oz	4,571	3,541
Osmium and osmiridium, oz	6,944	5,967
Palladium, oz	5,236	11,216
Rhodium and ruthenium, oz	1,328	2,712
Quicksilver	1,705,890	1,075,809
Nickel: Ore and matte	10,744,474	17,077,501
In pigs, ingots and other forms	27,296,739	44,682,732
Manganese ore, tons	273,568	187,874
Chrome ore, tons	203,674	200,426
Tin, bars, blocks, pigs, lb	150,491,112	162,816,103
Tungsten	1,566,882	2,297,725
Ferrochromium, chromium metal and chrome-vanadium	995,985	1,498,678
Ferrosilicon (silver content)	15,602,664	7,863,881

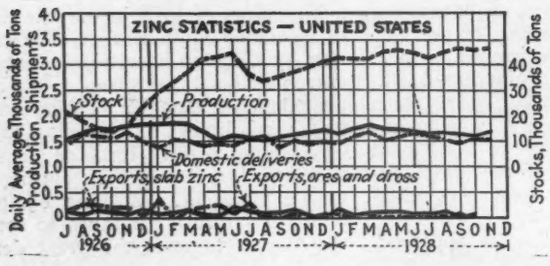
VII—Imports of Non-Metallic Minerals

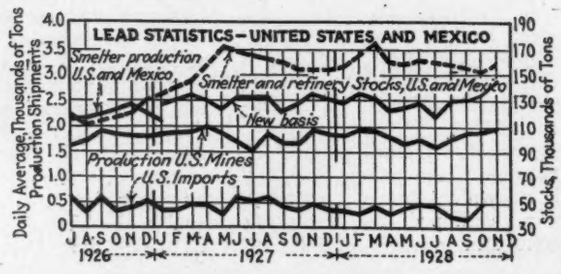
Bauxite, tons	330,512	326,873
Marble, cu.ft	905,985	546,568
Sand and gravel, tons	644,142	657,723
Lime and limestone, lb	48,435,199	50,399,302
Kaolin, china and paper clay, tons	274,587	237,915
Other clays, n.e.s	50,879	50,756
Corundum, tons	1,133	1,308
Emery, tons	2,726	4,846
Flint, tons	13,091	13,393
Asbestos, unmanufactured, tons	184,886	.....
Asbestos, manufactured, lb	130,565,684	55,234,739
Cryolite, tons	5,063	6,852
Chalk, crude, tons	104,462	86,781
Fluorspar, tons	59,433	41,253
Gypsum, crude, tons	685,657	826,103
Mica, crude	688,512	447,837
Mica, cut, split	2,416,223	2,952,359
Diamonds, rough, carats	212,635	273,206
Cut, unset, carats	406,119	404,641
Pyrites, tons	243,287	441,496
Talcum, steatite, French chalk, lb	46,986,139	48,554,813
Magnesite, lb	108,877,283	117,074,455
Salt, lb	91,094,827	66,705,897
Graphite	32,695,145	32,291,144
Mineral wax	6,862,328	10,113,957
Iodine, crude	881,017	706,525
Nitrate, sodium, tons	682,236	947,520
Ochers and sienna	19,157,373	20,261,433
Lithopone and other zinc pigments	18,362,286	20,930,901
Potash, tons: Crude chloride, tons	157,275	222,246
Crude, sulpnate, tons	62,383	79,424
Kainite, tons	96,704	102,849
Manure salts, tons	258,964	388,602

VIII—Iron Ore and Pig Iron

Exports		
Iron ore, tons	897,282	1,269,202
Pig iron, tons	47,913	76,268
Imports		
Iron ore, tons	2,488,880	2,280,247
Pig iron, tons	118,269	129,869

Production, Stocks, Imports, and Exports of Lead and Zinc


ZINC STATISTICS — UNITED STATES
Daily Average, Thousands of Tons Production Shipments
Stocks, Thousands of Tons
Stock
Production
Domestic deliveries
Exports, slab zinc
Exports, ores and dross
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928


LEAD STATISTICS—UNITED STATES AND MEXICO
Daily Average, Thousands of Tons Production Shipments
Stocks, Thousands of Tons
Smelter production U.S. and Mexico
Smelter and refinery Stocks, U.S. and Mexico
New basis
Production U.S. Mines
U.S. Imports
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926
1927
1928

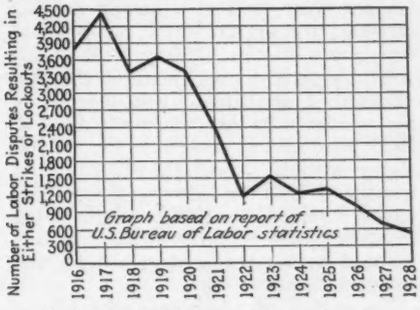
Industrial Relations and Employment Conditions

By H. D. Keiser
Assistant Editor

CONTINUED improvement in industrial relations and satisfactory employment conditions prevailed in practically all metal-mining districts of the United States throughout 1928. An adequate supply of both skilled and unskilled workers was available, and at the same time little unemployment was evident. No labor disturbances of any consequence occurred, and in this respect the industry was in accord with the general labor situation of the country, as indicated in the accompanying chart based on reports of the U. S. Bureau of Labor Statistics. Considerable attention on the part of metal-mining companies was given to the subject of group insurance, and a desire for greater co-operation between employer and employee, reduction of labor turnover, and better health and working conditions was apparent in the interest the subject received. Accident prevention, first-aid, and mine rescue training, besides the various phases of industrial welfare endeavor, all expanded during 1928; numerous safety records were established; and the annual first-aid and mine rescue contest held in August at Butte, Mont., under the auspices of the U. S. Bureau of Mines, was the most successful in the history of the contests. Wage scales remained about as they were in 1927—that is, with the exception of those in the copper-mining districts, where, in most instances, they were increased during the latter part of the year, when the price of copper advanced.

The number of men employed at Arizona copper mines gradually increased toward the close of the year as production schedules were raised. Labor supply was plentiful and predominantly Mexican, although more American miners were employed in the Miami district during the latter part of 1928 than at any other time in the last few years. Wages in effect at Globe, Miami, Bisbee, and Jerome as the year closed were: timbermen, $5.75 per eight-hour shift; miners, $5.45 per shift; and muckers, $4.84 per shift. Prior to Oct. 1 these wages were 10 per cent less. At most of the other camps in the state wages were slightly lower, but bonus and contract methods of payment in force at practically all camps make accurate comparisons impossible. Earnings of skilled miners probably averaged about the same in all the large mining districts of Arizona. At Miami Copper, workers on bonus earned as much as $10 per day, and wages of a few of the expert timbermen averaged more than this amount over a period of months.

No shortage or noticeable surplus of labor occurred at Nevada mining camps during 1928. In the Tonopah district few men were unemployed, and at no time did the mines lack men for all classes of work. Operations that were begun at Tybo by Treadwell Yukon wiped out for a time the floating labor supply at Tonopah, the state source of mine labor, but conditions there were soon normal again. Wage scales remained the same as in 1927, with the exception of that of Nevada Consolidated, which was increased when the price of copper advanced.



Industrial Disputes Show Steady Decline

Labor conditions in the Cœur d'Alene district throughout 1928 could hardly have been more satisfactory, so far as relations between employers and employees were concerned. No strikes occurred or were threatened, and in fact no controversies of any kind marred the cordial industrial relations prevailing in the district. According to careful estimates, 4,500 men were employed in the district at the close of the year. Miners receive $5 per day, muckers $4.50, timbermen $5.50, timberman helpers $4.75, hoistmen $5.75, motormen $4.75, trainmen $4.50, millmen $4.75, blacksmiths $5.75, carpenters $5.75, and surface labor $4.25. A sliding scale of wages was adopted about four years ago, based on the price of lead, but this has been ignored by the operators since the slump in the price of the metal. This scale makes $3.75 the basic wage when lead is less than 6c. per pound. A bonus of 25c. is added to wages for each half-cent increase in the pound price of the metal. According to this scale, the price of lead would have to be 8c. to make miners' wages $5 per day. The operators voluntarily agreed that miners' wages should not be less than $5, and since the price dropped below 8c. they have disregarded the sliding scale and maintained wages at that figure and at corresponding rates for all other employees.

In the Joplin-Miami zinc and lead district labor conditions in 1928 were probably more satisfactory than during any previous year. A constant surplus of labor was available, but on the other hand the majority of the efficient and willing workers were employed. Mines of the district were worked at considerably below capacity, and an average of about 100 mills operated throughout the year, as compared with 125 mills in 1927, and 140 in 1926. Wages remained unchanged throughout the year. Ordinarily the producers of the field adhere to a sliding scale of wages, based upon the base price paid for zinc concentrates; this provides for a 25c. adjustment in the daily wage scale for each $5 change in the ore price. When zinc declined below $40 a ton at the end of 1927 the operators did not make a cut in wages. As the price of zinc ore fluctuated between $36 and $40 throughout the year, no change has therefore been justified. The current daily wage scale for the district follows: machine men, $4.50; machine helper, $4.25; hoistermen, $5.50; blacksmiths, $5.50; and blacksmith helper, $4. Mill foremen are paid $45 a week; cleaner and rougher jig millmen, $4.50 a day; "jack" shovelers, $3.50; engineers, $45 a week and shovelers from 9 to 12c. a can, depending on shoveling conditions and the size of cans. Cans, filled, weigh from 1,200 to 1,800 lb.

Well-balanced working forces and a generally satisfactory labor situation prevailed in the Michigan copper district during 1928. At the close of the year, Calumet & Hecla Consolidated was employing 400 more men than in December, 1927. The majority of these were married men, and their presence has brought additional prosperity to Calumet. Houses which had been idle for years are being renovated and improved. They are being occupied as soon as this work is completed, and are rented to employees at the rate of $1 per room per month. Calumet & Hecla will need more men when it opens No. 17 shaft on the Osceola lode within the next few months. Other companies are also well supplied with men for present purposes, and the entire district is benefiting from the impetus given the industry by 16c. copper. No change in wage schedules has been made in the district, owing largely to the fact that the majority of the men are on contract, which enables them to increase their earnings above schedule rates. Base rate for trammers in the Calumet & Hecla mines is $3.60 per day, and for miners $4.20. Comparatively few men, however, are receiving the minimum. Most of the contract trammers are making about $5 per day and contract miners, $5.50. In some cases, miners are making as high as $9. Similar systems are in other mines in the district, and the rates vary but little.

No labor disturbances of any kind occurred in 1928 to upset the prosperity of the metal-mining industry of Utah. The supply of labor was adequate. On Oct. 1, when the price of copper started upward, Utah Copper advanced wages 50c. a shift for all employees making $4

a day and over, and for those making less than $4 a day wages were increased 40c. a shift. The wage scale at Utah mines ranges from $4.50 for mine labor to $5.75 a day for machinists, machine men receiving $5.25, miners $5, timbermen $5.25, and muckers $4.75. Some companies operating hot, dry mines, such as the Tintic Standard, pay 25c. to 50c. more a shift, whereas some others pay equal amounts less than these rates, but the scale given strikes a fair average of underground wages in Utah nonferrous metal mines. An important step in the working toward better health and safety conditions in Utah mines has been the establishment of a U. S. Bureau of Mines safety and rescue station at the new University of Utah mines building with Dr. Dorsey J. Parker, supervising engineer, in charge. Equipment for training and for emergencies has been installed.

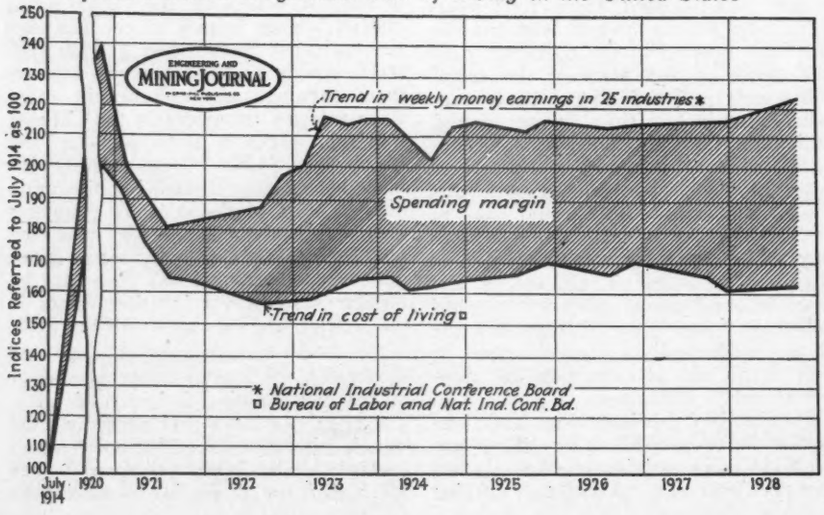
During 1928 workers in the metal mines of Montana were apparently well satisfied both with wages and working conditions. Most of the metal mining is confined to the Butte district, where wages were advanced 50c. per shift to a basis of $5.25 per shift for underground workers. Much of the underground work is performed on a contract basis, and the contract scale was also alvanced in proportion to the increase made in daily wages. Companies operating in the district expanded their accident prevention programs during the year, and the first-aid team from the Great Falls plant of Anaconda Copper won the international contest held in Butte last August under the auspices of the U. S. Bureau of Mines. Labor had ample opportunity for employment throughout the year, and at the close of 1928 a shortage of good miners prevailed as a result of Anaconda Copper reopening four mines. Early in 1929 North Butte Mining expects to start operations with a large crew. On account of the advance in wages and the new mining developments under way throughout the state, the metal-mining industry seems to be more active than it has been since 1906—that is, with the exception of the war period.

The wage scale in effect at Copperhill, Tenn., during the first eight months of 1928 was the same as it had been for the last five years. On Sept. 1, 1928, an increase of 2c. per hour was granted. The present daily rates follow: drillers, $3.92 for eight hours and trammers $3.60 for eight hours. A large percentage of the drilling and tramming is done by contract, however, and the average daily wage of contract drillers is about $5.95 per day, for contract trammers about $4.92 per day. Average daily wages for all men in mining departments is about $4.14 for eight hours.

The labor supply in the district was ample, and consisted of all white, native Americans. Mining forces at Tennessee Copper were held at a steady number all year, the present crew being about forty more than in January, 1928. Considerable progress was made in the prevention of accidents. Frequency rate for accidents in the company's mine in 1923 was 23.05 accidents for 10,000 shifts worked. For the first eleven months of 1928 the rate was 2.52. This means a reduction of 89 per cent in the frequency rate. The severity rate was reduced to a greater degree than the frequency rate.

An excess of labor prevailed in the Lake Superior iron-ore district during 1928, owing largely to the use of more scrapers and small hoists underground. Some mines are extracting 100 per cent additional tonnage with no increase in personnel, as a result of employing these labor-saving devices. Use of large shovels with crawler traction in the open pits has also reduced working forces. One encouraging sign is that mines which were operating on a reduced basis during the summer months returned to full production schedules toward the close of the year. Exploration work, however, was practically at a standstill, a result of the heavy taxes that are imposed on a property as soon as a new orebody is discovered thereon.

Spread Between Wages and Cost of Living in the United States



Transportation

By F. R. Raiff

CAPITAL expenditures during 1928 by the railroads of the United States for new equipment and additions and betterment of property are estimated at $650,000,000, as compared with an average of $750,000,000 for the previous eight years. Total expenditures for these purposes during the nine years totaled $6,628,300,000. Increases in efficiency of service, average freight-car mileage and loading, besides more prompt and regular movement of commodities, were obtained by these expenditures.

Freight train mileage per day is 309, which is an increase of 20 per cent over that of 1923, and, owing to the use of heavier locomotives and larger cars, carriers are moving greater loads on freight trains at a faster speed than ever before. The average car-load is slightly less than it was in 1927, the responsibility for which practice is shared by both shipper and carrier. An important factor in railroad economies has been the reduction of fuel consumption in handling freight trains. During 1928 22 per cent less fuel was used than in 1923 for the same service. Car loadings of revenue freight during 1928 totaled 51,576,732, which was 1,522,088 cars less than in 1926, and 59,075 less than in 1927. Railroad base rates for movement of non-ferrous metals or ores remained unchanged in general, however; some minor changes, local in character, were made by carriers to encourage shipments or to take care of altering conditions between mines and smelters. No major consolidations of railroads were effected. Several such proposals, however, are before the Interstate Commerce Commission for consideration, but probably further legislation will be required before these can be consummated.

Labor troubles during 1928 were unimportant, althought one of serious proportions was threatened by demands of Western trainmen for wage increases. Fifty-five Western railroads and 42,000 men were involved in this controversy, which was finally settled by a board appointed by the President. On recommendation of the board, and as accepted by the carriers and employees, annual wage increases of about $6,500,000 were awarded, and by a decision rendered Nov. 23 these increases were made retroactive to May 1, 1928.

Rates for transportation by water continued on practically the same basis as during the previous year. Contracts now being made with the transatlantic lines for 1929 business, however, are from 5 to 10 per cent higher than those of 1928. Transpacific rates, thus far, have exhibited no tendency to increase. Cargo tonnage through the Panama Canal for the fiscal year ended June 30, 1928, surpassed that for any similar previous period.

Mining Dividends Paid in 1927 and 1928

North and South American Companies

Compiled by *Engineering and Mining Journal*

Official data supplied by individual companies except when indicated by an asterisk (*) in which case it is from published reports

Company, Metals Mined, and Class of Stock	Situation	Shares Outstanding	Par Value	1927 Per Share	1927 Total	1928 Per Share	1928 Total	Total Paid to End of 1928	Latest Dividend Paid to Dec. 31, 1928 Date	Per Share
*Aluminum Co. of A., pfd	Various	1,472,620	$100	$6.00	$8,835,720	$6.25	$9,218,875	.....	Oct., 1928	$1.75
*American Metal	Various	594,836	No	3.00	1,783,903	3.00	1,783,904	.....	Dec., 1928	0.75
*American Metal, 7% pfd	Various	50,000	100	7.00	350,000	3.50	175,000	.....	June, 1928	1.75
*American Metal, 6% pfd	Various	100,000	100	.....	.....	4.50	217,500	.....	Dec., 1928	1.50
*American Smelting & Refining	Various	609,980	100	8.00	4,879,840	8.00	4,879,840	.....	Nov., 1928	2.00
*American S. & R., pfd	Various	500,000	100	7.00	3,500,000	7.00	3,500,000	.....	Dec., 1928	1.75
*Anaconda Copper Mining	Various	3,585,970	50	3.00	9,000,000	3.50	10,500,000	.....	Nov., 1928	1.00
*Arizona Commercial, c	Arizona	265,000	5	0.75	198,750	0.25	66,250	2,279,000	Jan., 1928	0.25
*Bethlehem Steel, pfd	Various	970,000	100	7.00	6,777,660	7.00	6,777,660	.....	Oct., 1928	1.75
Betty O'Neal Mines, s	Nev., Ariz.	465,060	5	0.20	93,052	0.05	23,253	481,706	Feb., 1928	0.05
*Bingham Mines Co., s, l	Utah	50,000	10	4.00	200,000	3.25	162,500	1,354,875	Oct., 1928	0.50
*Bunker Hill & Sullivan, l, s	Idaho	327,000	10	9.00	2,943,000	9.00	2,943,000	42,777,379	Dec., 1928	0.75
*Bunker Hill & Sullivan, pfd	Idaho	6,227	100	9.00	50,628	9.00	65,832		Oct., 1928	2.25
Butte & Superior, z, c	Mont.	290,198	10	2.00	580,395	2.00	580,395	19,697,136	Dec., 1928	0.50
Caledonia Mining, s, l	Idaho	2,605,000	1	0.15	390,750	.....	.....	4,699,056	Dec., 1927	0.05
*California Rand, s, g	Calif.	1,280,000	1	0.20	256,000	0.06	77,800	4,595,600	Nov., 1928	0.01
Calumet & Arizona, c, s, g	Ariz.	642,757	10	6.00	3,856,542	7.00	4,499,297	66,517,883	Dec., 1928	2.50
Calumet & Hecla, c	Mich.	2,005,502	25	2.00	4,011,004	2.50	5,013,775	17,046,767	Dec., 1928	1.00
*Chief Consolidated, s, l	Utah	1,142,860	1	.....	.....	0.10	114,286	3,654,519	Feb., 1928	0.10
*Cleveland Cliffs Iron	Mich., Minn.	400,000	No	3.00	1,200,000	4.00	1,600,000	.....	Oct., 1928	1.00
*Colorado Fuel & Iron, pfd	Colo., Wyo.	20,000	100	8.00	160,000	8.00	160,000	.....	Nov., 1928	2.00
Consolidated Lead & Zinc, l, z	Kan., Okla.	200,000	No	0.25	50,000	0.50	100,000	555,000	July, 1928	0.25
Copper Range, c	Mich.	394,755	25	1.00	394,693	1.00	394,755	29,760,911	April 1928	1.00
Cresson Consol. Gold	Colo.	1,220,000	1	0.40	488,000	0.32	390,400	12,149,472	Oct., 1928	0.02
Douglas Mining, s, z, l	Idaho	938,500	1	0.0175	14,936	.....	.....	.....	Dec., 1927	0.0175
*Eagle-Picher Lead, l, z	Okla.	1,000,000	20	1.60	1,200,000	.....	.....	.....	Dec., 1927	0.40
*Eagle-Picher Lead, Pfd	Okla.	8,513	100	6.00	51,078	6.00	51,078	.....	Oct., 1928	1.50
Fanny Rawlings, c, s, g	Colo.	995,229	1	0.005	4,976	.....	.....	.....	July, 1927	0.005
*Federal Mng. & Smg., s, l, z	Ida., Mo., Kan.	50,400	100	10.00	504,000	.....	.....	.....	July, 1927	10.00
*Federal Mng. & Smg., pfd	Ida., Mo., Kan.	72,000	100	7.00	560,000	7.00	504,000	.....	Dec., 1928	1.75
*Freeport Texas, su	Texas	729,844	No	4.25	3,101,837	6.50	4,743,986	.....	Nov., 1928	1.25
General Development	Various	120,000	20P	1.00	120,000	.....	.....	.....	Nov., 1927	0.25
Gladstone Mountain, l	Wash.	1,321,890	0.10	0.03	39,657	.....	.....	198,283	June, 1927	0.005
Golden Cycle, g	Colo.	1,500,000	1	0.16	240,000	0.16	240,000	10,883,300	Dec., 1928	0.04
Granite Gold	Colo.	1,600,500	1	0.03	48,015	.....	.....	468,000	April, 1927	0.03
*Great Northern Iron Ore	Minn.	1,500,000	No	1.50	2,250,000	2.75	4,125,000	.....	Dec., 1928	2.00
Hecla Mining Co., l, s	Idaho	1,000,000	0.25	1.00	1,000,000	0.70	700,000	17,805,000	Dec., 1928	0.15
*Homestake Mining, g	So. Dak.	251,160	100	7.00	1,758,120	6.00	1,506,960	53,850,124	Dec., 1928	0.50
*Inland Steel Co	Minn.	1,182,799	No	2.50	2,956,998	2.5425	3,007,265	.....	Dec., 1928	0.625
*Inland Steel Co., pfd	Minn.	100,000	100	7.00	700,000	7.00	700,000	.....	Oct., 1928	1.75
Inspiration Consol. Copper	Ariz.	1,181,967	20	0.75	886,475	.....	.....	45,786,011	May, 1927	0.75
Iron Cap Copper, pfd	Ariz.	18,681	10	0.60	11,208	.....	.....	1,078,378	Nov., 1927	0.15
Isle Royale Copper	Mich.	150,000	25	1.00	150,000	1.75	262,500	3,112,500	Dec., 1928	0.50
Kennecott Copper	Alaska	4,551,015	No	5.00	22,520,606	5.25	23,806,867	152,594,087	Oct., 1928	1.50
Lone Pine Surprise	Wash.	3,126,000	0.03	.....	.....	0.02	62,520	62,520	July, 1928	0.01
Magma Copper Co	Ariz.	408,155	No	3.00	1,224,465	3.00	1,224,465	5,989,628	Oct., 1928	0.75
*Mammoth Mining, l, c, s, g	Utah	395,814	0.10	0.60	237,488	.....	.....	3,138,127	.....	.....
Miami Copper	Ariz.	747,116	5	1.50	1,120,674	1.50	1,120,674	32,943,317	Nov., 1928	0.375
*Mohawk Mining, c	Mich.	115,000	25	5.00	575,000	6.00	690,000	12,590,000	Dec., 1928	3.00
*Mother Lode Coalition, c, s	Alaska	2,500,000	No	0.50	1,250,000	0.35	875,000	12,750,000	Dec., 1928	0.20
*National Lead Co	Various	309,831	100	5.75	1,574,803	5.00	1,549,155	81,178,784	Dec., 1928	1.25
*National Lead Co., pfd. A	Various	243,626	100	7.00	1,705,732	7.00	1,705,732		Dec., 1928	1.75
*National Lead Co., pfd. B	Various	103,277	100	3.00	309,717	6.00	619,662		Nov., 1928	1.50
*Nevada Consol. Copper	Nev.,Ariz., N.M.	4,855,109	No	1.50	5,582,644	1.625	7,889,552	59,075,859	Dec., 1928	0.50
*New Cornelia Copper	Ariz.	1,800,000	5	2.00	3,600,000	2.00	3,600,000	17,730,000	Nov., 1928	0.50
New Jersey Zinc	Various	490,816	100	12.00	5,889,792	12.00	5,889,792	.....	Dec., 1928	2.00
Newmont Mining, h	Various	477,608	10	3.20	1,435,896	4.00	1,884,784	4,611,280	Oct., 1928	1.00
Night Hawk Leasing, c	Ariz.	100,000	1	0.40	40,000	0.65	65,000	525,000	Dec., 1928	0.25
Nichols Copper, A	N. Y.	91,824	No	.....	.....	0.4375	40,247	.....	Oct., 1928	0.4375
Nichols Copper, B	N. Y.	73,348	No	.....	.....	1.00	73,348	.....	Dec., 1928	0.50
Nichols Copper, old pfd	N. Y.	22,956	100	7.00	160,898	5.25	10,741	.....	July, 1928	1.75
North Lily, s, l	Utah	795,550	0.10	.....	.....	0.20	159,110	159,110	Oct., 1928	0.20
*Park-Utah Consolidated, s, l, z	Utah	2,093,500	1	0.75	1,570,125	0.80	1,674,800	4,811,300	Oct., 1928	0.20
Phelps Dodge Corporation, c	Various	500,000	100	6.00	3,000,000	7.00	3,500,000	.....	Oct., 1928	2.00
*Plutus Mining, g, s, l, z, c	Utah	997,145	0.10	0.60	599,287	0.10	99,715	997,865	April, 1928	0.10
*Portland Gold Mining	Colo.	3,000,000	1	0.04	120,000	.....	.....	11,992,080	April, 1927	0.02
*Republic Iron & Steel	Mich., Ala.	300,000	100	4.00	1,200,000	4.00	1,200,000	.....	Dec., 1928	1.00
*Republic Iron & Steel, pfd	Mich., Ala.	250,000	100	7.00	1,750,000	7.00	1,750,000	.....	Oct., 1928	1.75
*St. Joseph Lead	Various	1,950,438	10	3.00	5,851,305	3.00	5,851,305	.....	Dec., 1928	0.75
St. Mary's Mineral Land Co	Mich.	160,000	25	2.00	320,000	3.00	480,000	.....	Dec., 1928	1.00
*Sidney Leasing, s, l, s	Idaho	5,000	5	10.00	50,000	.....	.....	.....	.....	.....
*Sidney Mining, s, l, z	Idaho	1,500,000	1	0.02	30,000	0.01	15,000	.....	July, 1928	0.01
Silver King Coalition, s, l	Utah	1,216,100	5	1.10	1,337,710	1.10	1,337,710	22,866,137	Dec., 1928	0.10
*Sloss-Sheffield Iron	Ala.	100,000	100	6.00	600,000	6.00	600,000	.....	Dec., 1928	1.50
*Sloss-Sheffield Iron, pfd	Ala.	67,000	100	7.00	469,000	7.00	469,000	.....	Oct., 1928	1.75
Sunshine Mining Co., c, s	Idaho	1,500,000	0.10	0.08	120,000	0.12	180,000	300,000	Dec., 1928	0.02
Tennessee Copper & Chem	Tenn.	794,626	No	0.50	397,313	0.75	595,970	3,494,215	Dec., 1928	0.25
Texas Gulf Sulphur	Texas	2,540,000	No	4.00	10,160,000	4.00	10,160,000	46,037,500	Dec., 1928	1.00
Tintic Standard, s, l	Utah	1,152,915	1	1.70	1,959,955	1.40	1,614,631	11,057,255	Dec., 1928	0.20
Tonopah Mining Co., s, g	Nev.	1,000,000	1	0.15	150,000	0.15	150,000	16,725,000	Oct., 1928	0.075
United Gold Mines	Colo.	4,801,739	0.10	0.01	48,017	0.02	96,034	896,964	July, 1928	0.01
U. S. Smelting, Ref., & Min	Various	350,115	50	3.50	1,228,903	3.50	1,228,903	58,291,560	Oct., 1928	0.875
U. S. Smelting, Ref., & Min., pfd	Various	486,350	50	3.50	1,702,225	3.50	1,702,225		Oct., 1928	0.875
U. S. Steel Corp	Various	7,116,235	100	7.00	46,258,899	7.00	49,813,645	1,490,121,281	Dec., 1928	1.75
U. S. Steel Corp., pfd	Various	3,602,811	100	7.00	25,219,677	7.00	25,219,677		Nov., 1928	1.75
United Verde Copper	Ariz.	300,000	No	12.00	3,600,000	15.00	4,500,000	.....	Nov., 1928	3.00
*United Verde Extension	Ariz.	1,050,000	0.50	3.00	3,150,000	2.00	2,100,000	32,655,000	Nov., 1928	0.50
Utah Apex Mining, l, c, s, g	Utah	528,200	5	.....	.....	0.25	132,050	3,235,225	Aug., 1928	0.25
*Utah Copper Co	Utah	1,624,490	10	6.00	9,746,940	8.00	12,995,916	169,991,297	Dec., 1928	3.00
Vanadium Corp. of America	Various	376,637½	No	4.00	1,513,468	4.00	1,506,548	.....	Dec., 1928	1.00
*Virginia Iron, C. & C., pfd	Va., Ky.	50,000	100	5.00	250,000	5.00	250,000	.....	July, 1928	2.50
Foreign										
Ahumada Lead, l, s	Mex.	1,192,018	1	0.275	327,805	.....	.....	3,246,999	April, 1927	$0.125
Amparo Mining, g, s	Mex.	2,000,000	1	0.05	100,000	0.04	80,000	5,272,177	Nov., 1927	0.01
Andes Copper	Chile	3,093,803	No	.....	.....	0.75	2,320,352	2,320,352	Dec., 1928	$0.75
Aramayo Mines, s, t, b, c	Bolivia	840,000	25 Sw. fr.	2½fr.	2,100,000fr.	2½fr.	2,100,000fr.	5,272,177fr.	April, 1928	1½fr.
*Asbestos Corp., pfd	Que.	74,561	$100	$7.00	$521,927	$7.00	$521,927	.....	Oct., 1928	$1.75
*Camp Bird, pfd., g, s	Colo.	649,625	£1	9.6d.	£25,985	.....	.....	.....	Jan., 1927	9.6d.
Cerro de Pasco Copper, c, s, l	Peru	1,122,842	No	$4.00	$4,491,368	4.50	5,052,789	.....	Nov., 1928	1.25
*Chile Copper Company	Chile	4,415,497	$25	2.60	11,023,645	2.825	11,590,681	66,457,089	Dec., 1928	0.75
*Consolidated M. & S., c, l, z, s	B. C.	508,557	25	12.50	6,354,862	12.50	6,354,862	26,228,550	July, 1928	6.25
*Dome Mines, g	Ont.	953,334	No	1.25	1,191,666	1.00	953,334	12,977,088	Oct., 1928	0.25

P, reduced from $25 per share in 1928: c, copper: l, lead: s, silver: g, gold: t, tin: b, bismuth: z, zinc: n, nickel; h, holding: su, sulphur.

Mining Dividends Paid in 1927 and 1928—Continued

Company, Metals Mined, and Class of Stock	Situation	Shares Outstanding	Par Value	1927 Per Share	1927 Total	1928 Per Share	1928 Total	Total Paid to End of 1927	Latest Dividend Paid to Dec. 31, 1928 Date	Per Share
*Erupcion Mining, l, s	Mex.	1,250,000	1	$0.325	$406,250	$0.075	$93,750	$2,906,250	Jan., 1928	$0.075
*Frontino & Bolivia, g	Colombia	140,000	£1	2s.	£14,000	1s.9d.	£12,250	.....	July, 1928	9d.
*Frontino & Bolivia, pfd	Colombia	23,390	£1	2s.	£2,339	2s.	£2,339	.....	July, 1928	1s.
*Granby Consolidated, c	B. C.	446,603	$100	$1.00	$432,262	$3.00	1,339,809	12,111,529	Nov., 1928	1.00
*Hollinger Consol. Gold	Ont.	4,920,000	5	1.30	6,396,000	1.10	5,412,000	42,374,400	Dec., 1928	0.05
*Howe Sound Co., c, l, s	Mex., B. C.	496,038	No	4.00	1,984,152	4.00	1,984,152	7,242,153	Oct., 1928	1.00
*International Nickel, n, c	Ont.	1,673,384	25	2.00	3,346,768	2.50	4,183,460	.....	Dec., 1928	0.75
*International Nickel, pfd	Ont.	89,126	100	6.00	534,756	6.00	534,756	.....	Nov., 1928	1.50
Keeley Silver Mines	Ont.	2,000,000	1	0.20	400,000	0.04	80,000	2,240,000	Mar. 1928	0.04
*Kerr Lake Mines, s	Ont.	600,000	4	0.06	36,000	.....	.....	10,371,000	April, 1927	0.06
Lake Shore Mines, g	Ont.	2,000,000	1	0.70	1,400,000	1.00	2,000,000	6,020,000	Dec., 1928	0.40
Lucky-Tiger Combination, g, s	Mex.	715,337	10	0.67	479,280	0.81	579,423	13,170,809	Dec., 1928	0.12
McIntyre-Porcupine, g	Ont.	798,000	5	1.00	798,000	1.00	798,000	7,401,908	Dec., 1928	0.25
*Mining Corp. of Canada, s	Ont.	1,660,050	5	$0.25	$415,012	0.25	415,012	6,951,412	July, 1928	0.125
*Mond Nickel Co., c, n	Ont.	900,000	£1	2s.6d.	£112,500	5s.6d.	£247,500	.....	Aug., 1928	4s.
*Mond Nickel, pfd., 7% cum	Ont.	500,000	£1	1s.4.8d.	£35,000	1s.4.8d.	£35,000	.....	.....	.....
*Mond Nickel, 7% "A" cum	Ont.	1,250,000	£1	1s.4.8d.	£87,500	1s.4.8d.	£87,500	.....	.....	.....
*Mond Nickel, pfd. non-cumulative	Ont.	2,000,000	£1	1s.4.8d.	£140,000	1s.4.8d.	£140,000	.....	.....	.....
*N. Y. & Honduras Rosario, s, g	Honduras	200,000	$10	$2.00	$400,000	$1.75	$350,000	$8,100,000	Dec., 1928	$0.25
Nipissing Mines Co., s	Ont.	1,200,000	5	0.45	540,000	0.30	360,000	29,040,000	Oct., 1928	0.075
*Oroville Dredging Co., g	Colombia	715,636	£1	1s.3d.	£44,727	.....	.....	.....	Nov., 1927	1s.3d.
*Patino Mines & E., t	Bolivia	1,045,100	$20	8s.	£418,040	12s.	£627,060	£3,253,104	Dec., 1928	4s.
*Premier Gold Mining, s, g	B. C.	5,000,000	$1	$0.32	$1,600,000	$0.28	$1,400,000	$12,350,000	Oct. 1928	$0.06
St. John del Rey, g	Brasil	546,265	£1	9d.	£20,485	1s.6d.	£40,970	£1,643,579	Dec., 1928	6s.
St. John del Rey, pfd	Brazil	100,000	£1	2s.	£10,000	2s.	£10,000		Dec., 1928	1s.
*San Francisco Mines, s, s, g	Mexico	1,503,959	10s.	.4s	£300,792	3s.9d.	£283,243	£1,335,869	July, 1928	1s.3d
*Santa Gertrudis, g, s	Mexico	1,553,400	£1	2s.3d.	£174,757	3s.	£233,010	£1,550,594	July, 1928	1s.6d.
Teck-Hughes Gold Mines	Ont.	4,757,144	$1	$0.15	$713,572	$0.60	2,860,286	$4,048,572	Nov., 1928	$0.15
Vipond Consolidated, g	Ont.	2,250,000	1	0.03	67,500	.....	.....	67,500	April, 1927	0.03
Wright-Hargraves, g	Ont	5,500,000	No	0.35	1,237,500	0.15	825,000	4,331,250	Nov., 1928	0.025

Mining Directory

Professional Organizations

American Association of Petroleum Geologists, Box 1852, Tulsa, Okla.
American Chemical Society, 1709 G St., N.W., Washington, D. C.
American Electrochemical Society, Columbia University, New York.
American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York.
American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.
Australasian Institute of Mining and Metallurgy, 48 Queen St., Melbourne, Victoria, Australia.
Canadian Institute of Mining and Metallurgy, Drummond Building, Montreal, Quebec, Canada.
Chemical, Metallurgical and Mining Society of South Africa, 100 Fox St., Johannesburg, Transvaal, South Africa.
China Institution of Mining and Metallurgy, 13 K' Vei Chia Ch' Ang, Peking, China.
Geological Society of America, Museum of Natural History, Columbus Ave. and 77th St., New York.
Geological Society of London, Burlington House, London W., England.
Geological Society of Washington, U. S. Geological Survey, Washington, D. C.
Institution of Mining and Metallurgy, 225 City Road, London E. C. 1, England.
Mining and Metallurgical Society of America, 2 Rector St., New York.
Society of Chemical Industry, Central House, Finsbury Square, London, E. C.2, England; Pratt Institute, Brooklyn, New York.
Society of Economic Geologists, 42 Broadway, New York.

Mining—Educational Institutions

United States

Alabama—Mine Experiment Station, University of Alabama, University. Ala.; J. R. Cudworth, acting director.
Alaska—Alaska Agricultural College and School of Mines, College, Alaska; C. E. Bunnell, president.
Arizona—College of Mines and Engineering, University of Arizona, Tucson, Ariz.; G. M. Butler, dean.
California—College of Mining, University of California, Berkeley, Calif.; F. H. Probert, dean.
School of Engineering, Department of Mining and Metallurgy, Stanford University, Palo Alto, Calif.; T. J. Hoover, dean.
Colorado—Colorado School of Mines, Golden, Colo.; M. F. Coolbaugh, president.
Connecticut—Department of Mining and Metallugy, Yale University, New Haven, Conn.; C. H. Mathewson, professor of metallurgy; Arthur Phillips, associate professor of metallurgy; R. K. Warner and H. A. Behre, assistant professors of mining.
Idaho—School of Mines, University of Idaho, Moscow, Idaho, E. W. Ellis, acting dean.
Illinois—Mining Engineering Department, University of Illinois, Urbana, Ill.; A. C. Callen, head.
Iowa—Mining Engineering Department, Iowa State College, Ames, Iowa; Prof. A. K. Friedrich.
Kansas—Department of Mining Engineering, University of Kansas, Lawrence, Kan.; Prof. C. M. Young, head.
Kentucky—Department of Mining Engineering, C. S. Crouse, acting head; Department of Metallurgical Engineering, C. S. Crouse, head, University of Kentucky, Lexington, Kentucky.
Massachusetts—Department of Mining and Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.; W. Spencer Hutchinson, head. Harvard Engineering School, Department of Mining, Harvard University, Cambridge, Mass. D. H. McLaughlin, professor of mining.
Michigan—Michigan College of Mining and Technology, Houghton, Mich.; W. O. Hotchkiss, president.
Minnesota—School of Mines, University of Minnesota, Minneapolis, Minn.; W. R. Appleby, dean.
Missouri—Missouri School of Mines and Metallurgy, Rolla, Mo.; Dr. C. H. Fulton, director.
Montana—Montana State School of Mines, Butte, Mont.; Francis A. Thomson, president.
Nevada—Mackay School of Mines, University of Nevada, Reno, Nev.; J. A. Fulton, director.
New Jersey—School of Engineering, Princeton University, Princeton, N. J.; A. M. Greene, Jr., dean.
New Mexico—New Mexico School of Mines, Socorro, N. M.; E. H. Wells, president.
New York—School of Mines, Columbia University, New York, N. Y.; E. J. Hall, executive officer.
Department of Geology, Cornell University, Ithaca, N. Y.; Prof. H. Ries, head.
North Dakota—College of Engineering and School of Mines, University of North Dakota, Grand Forks, N. D.; E. F. Chandler, dean.
Ohio—Department of Metallurgical and Mining Engineering, Case School of Applied Science, Cleveland, Ohio; H. M. Boylston, professor. Department of Mine Engineering, Ohio State University, Columbus, Ohio; H. E. Nold, professor.
Oklahoma—College of Engineering, University of Oklahoma, Norman, Okla.; J. H. Felgar, dean.
Oklahoma School of Mines and Metallurgy, Wilburton, Okla.; E. E. Tourtellotte, president.
Oregon—School of Mines, Oregon State College, Corvallis, Ore.; J. H. Hance, dean.
Pennsylvania—Department of Mining and Metallurgy, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.; J. Aston, professor and head of department, and J. D. Beatty, secretary, mining and metallurgical advisory boards. Department of Mining Engineering, Lehigh University, Bethlehem, Pa.; Prof. H. Eckfeldt, head. Department of Mining Engineering, Lafayette College, Easton, Pa.; W. B. Plank, head. School of Mines, University of Pittsburgh, Pa.; E. A. Holbrook, dean. School of Mines and Metallurgy, Pennsylvania State College, State College, Pa.; E. Steidle, dean.
South Dakota—South Dakota State School of Mines, Rapid City, S. D.; C. C. O'Harra, president.
Texas—College of Mines and Metallurgy, University of Texas, El Paso, Tex.; C. A. Puckett, dean.
Utah—Schools of Mines and Engineering, University of Utah, Salt Lake City, Utah; R. B. Ketchum, dean.
Virginia—Department of Mining Engineering, Virginia Polytechnic Institute, Blacksburg, Va.; Prof. O. C. Burkhart, head.
Washington—College of Mines, University of Washington, Seattle, Wash.; Milnor Roberts, dean. School of Mines and Geology, State College of Washington, Pullman, Wash.; A. E. Drucker, dean.
West Virginia—Department of Mining Engineering, West Virginia University, Morgantown, W. Va.; Prof. C. E. Lawall, head.
Wisconsin—Department of Mining and Metallurgy, University of Wisconsin, Madison, Wis.; Prof. R. S. McCaffery, chairman. Wisconsin Mining School, Platteville, Wis.; H. B. Morrow, director.
Wyoming—Department of Mining Engineering, University of Wyoming, Laramie, Wyo.; Prof. J. R. Guiteras, head.

Canada

McGill University, Montreal, Que.
Nova Scotia Technical College, Halifax, N. S.
Queen's University, Kingston, Ont.
University of Alberta, Edmonton, Alberta.
University of British Columbia, Vancouver, B. C.
University of Toronto, Queen's Park, Toronto, Ont.

U. S. Bureau of Mines

Washington, D. C.—Scott Turner, Director; Joseph H. Hedges, assistant to the director; John D. Secrest, chief clerk; George S. Rice, chief mining engineer.

Technologic Branch—Ozni P. Hood, chief and chief engineer mechanical division; Harry C. Fowler, acting chief engineer, petroleum and natural gas division; Roscoe A. Cattell, chief engineer, helium division; Charles W. Wright, chief engineer, mining division; Arno C. Fieldner, chief engineer, experiment stations division, and acting chief engineer, metallurgical division; Charles E. Munroe, chief engineer, explosives division.

Field Stations—Harry F. Yancey, acting supervising engineer, Seattle, Wash.; Henry H. Storch, supervising engineer, New Brunswick, N. J.; Will H. Coghill, supervising engineer, Rolla, Mo.; Chauncey F. Cook, supervising engineer, Forth Worth, Tex.; Eugene D. Gardner, supervising engineer, Tucson, Ariz.; Thomas L. Joseph, supervising engineer, Minneapolis, Minn.; Byron M. Bird, supervising engineer, Birmingham-Tuscaloosa, Ala.; Edmund S. Leaver, supervising engineer, Reno, Nev.; Dorsey A. Lyon, supervising engineer, Salt Lake City, Utah; Charles G. Maier, acting supervising engineer, Berkeley, Calif.; Nicholas A. C. Smith, supervising engineer, Bartlesville, Okla.; George St. J. Perrott, superintendent, Pittsburgh, Pa., station.

Field Offices—Clifford P. Bowie, supervising engineer, San Francisco, Calif.; Arthur W. Fahrenwald, supervising engineer, Moscow, Idaho; Harry B. Hill, supervising engineer, Dallas, Tex.; Albert J. Kraemer, supervising engineer, Rifle-Boulder, Colo.; Kenneth B. Nowels, supervising engineer, Laramie, Wyo.; Benjamin D. Stewart, supervising engineer, in charge of Alaskan work (by courtesy of Geological Survey, Department of the Interior).

Economics Branch—Charles P. White, chief and head of coal division; Frank J. Katz, chief engineer, mineral statistics division; Frank L. Hess, chief engineer, rare metals and non-metals division; Edward B. Swanson, acting chief engineer, petroleum economics division; Carl E. Julihn, chief engineer, common metals division.

Field Offices—John P. Dunlop, supervising statistician, Joplin, Mo.; Victor C. Heikes, supervising engineer, Salt Lake City, Utah; Charles W. Henderson, supervising engineer, Denver, Colo.; ————, supervising engineer, San Francisco, Calif.

Health and Safety Branch—R. R. Sayers, chief and chief surgeon, health division; Daniel Harrington, chief engineer, safety division.

Field Offices—Frank E. Cash, supervising engineer, Birmingham, Ala.; Edward H. Denny, supervising engineer, Denver, Colo.; John J. V. Forbes, supervising engineer, instruction section, Pittsburgh, Pa.; Frank S. Crawford, supervising engineer, Duluth, Minn; Charles A. Herbert, supervising engineer, Vincennes, Ind.; Dorsey J. Parker, supervising engineer, Salt Lake City, Utah; Frank V. Meriwether, acting assistant surgeon, Picher, Okla.; Arthur L. Murray, acting assistant surgeon, Salt Lake City, Utah; Charles P. Waite, acting assistant surgeon, Pittsburgh, Pa.

Administrative Branch—Joseph H. Hedges, chief; John A. Davis, chief engineer, information division; John D. Secrest, head, office administration division.

U. S. Geological Survey

Director, Dr. G. O. Smith.
Administrative Geologist, J. D. Sears.
Chief Clerk, J. J. Madigan.
Geologic Branch, W. C. Mendenhall.
Alaskan Branch, P. S. Smith.
Topographic Branch, C. H. Birdseye.
Water-Resources Branch, N. C. Grover.
Conservation Branch, Herman Stabler.
Editor, B. H. Lane.

State Geologists and Engineers

Alabama—Dr. W. B. Jones, State Geologist, University of Alabama, University, Ala.
Arizona—Dr. G. M. Butler, Director, Arizona Bureau of Mines, and State Geologist; University of Arizona, Tucson, Ariz.
Arkansas—G. C. Branner, State Geologist, Little Rock, Ark.; W. N. Wilkes, Commissioner of Mines, Manufactures, and Agriculture, Little Rock, Ark.
California—W. W. Bradley, State Mineralogist; State Division of Mines and Mining, Ferry Building, San Francisco.
Colorado—Prof. R. D. George, State Geologist, University of Colorado, Boulder, Colo.
Connecticut—Dr. W. E. Britton, Superintendent, State Geological and Natural History Survey, Connecticut Agricultural Experiment Station, New Haven, Conn.
Florida—Herman Gunter, State Geologist, Florida State Geological Survey, Tallahasse, Fla.
Georgia—Prof. S. W. McCallie, State Geologist, Geological Survey of Georgia, Atlanta, Ga.
Idaho—E. W. Ellis, Acting Secretary, Bureau of Mines and Geology, and Acting Dean, School of Mines, Moscow, Idaho.
Illinois—Dr. M. M. Leighton, Chief, State Geological Survey Division, Urbana, Ill.
Indiana—Prof. W. N. Logan, State Geologist, Department of Conservation, Division of Geology, Indianapolis, Ind.; T. M. Kingsbury, State Gas Supervisor.
Iowa—Prof. G. F. Kay, Director, Iowa Geological Survey, Iowa City, Iowa.
Kansas—Dr. R. C. Moore, State Geologist, University of Kansas, Lawrence, Kan.
Kentucky—Dr. W. R. Jillson, State Geolgist and Director, Kentucky Geological Survey, Frankfort, Ky.
Louisiana—Louisiana Geological Survey, Louisian State University, Baton Rouge, La.
Maryland—Dr. E. B. Mathews, State Geologist, Maryland Geological Survey, Johns Hopkins University, Baltimore, Md.
Michigan—R. A. Smith, State Geologist, Department of Conservation, Geological Survey Division, Lansing, Mich.
Minnesota—Prof. W. H. Emmons, Director, Minnesota Geological Survey, University of Minnesota, Minneapolis, Minn.
Mississippi—Dr. E. N. Lowe, State Geologist, Mississippi State Geological Survey, University, Miss.
Missouri—H. A. Buehler, State Geologist and Director, Bureau of Geology and Mines, Rolla, Mo.
Montana—Department of Geology, State University of Montana, Missoula, Mont.; Prof. J. P. Rowe, Head; C. H. Clapp, Professor of Geology.
Nevada—A. J. Stinson, Inspector of Mines, Carson City, Nev.; State Mining Laboratory, University of Nevada, Reno, Nev.; Prof. W. S. Palmer, Director.
New Jersey—Dr. H. B. Kummel, Director and State Geologist, Department of Conservation and Development, Trenton, N. J.
New Mexico—R. W. Ellis, Director, New Mexico Bureau of Mines and Mineral Resources, Socorro, N. M.
New York—D. H. Newland, State Geologist, University of the State of New York, Albany, N. Y.
North Carolina—Wade Phillips, Director, N. C. Department of Conservation and Development, P. O. Box 285, Raleigh, N. C.
North Dakota—Dr. A. G. Leonard, State Geologist, State Geological Survey, University of North Dakota, University, N. D.
Ohio—State Geologist, Geological Survey of Ohio, Columbus, Ohio.
Oklahoma—C. N. Gould, Director, Oklahoma Geological Survey, Norman, Okla.
Oregon—Mining Survey Office, School of Mines, Oregon State College, Corvallis, Ore.; J. H. Hance, Director.
Pennsylvania—Dr. G. H. Ashley, State Geologist, Topographic and Geological Survey, Harrisburg, Pa.
South Carolina—Prof. Stephen Taber, State Geologist, Columbia, S. C.
South Dakota—Dr. E. P. Rothreck, State Geologist, State Geological and Natural History Survey, University of South Dakota, Vermilion, S. D.
Tennessee—W. F. Pond, State Geologist, Department of Education, Division of Geology, Nashville, Tenn.
Texas—Dr. J. A. Udden, Director, Bureau of Economic Geology and Technology, 801 West 31st St., Austin, Tex.
Utah—Prof. William Peterson, State Geologist, Agricultural College of Utah, Logan, Utah.
Vermont—Dr. G. H. Perkins, State Geologist, Dean, University of Vermont, Burlington, Vt.
Virginia—W. A. Nelson, Head, Corcoran and Rogers School of Geology, University of Virginia, Charlottesville, Va.
Washington—H. E. Culver, Supervisor, Division of Geology, Department of Conservation and Development, and Head, Department of Geology, Washington State College, Pullman, Wash.
West Virginia—Dr. I. C. White, State Geologist, West Virginia Geological Survey, Morgantown, W. Va.
Wisconsin—E. F. Bean, Director, Geological and Natural History Survey, Madison, Wis.
Wyoming—J. G. Marzel, State Geologist; F. B. Taylor, Oil and Gas Inspector, Cheyenne, Wyo.

Trade Associations

General—American Bureau of Metal Statistics, 115 Broadway, New York; American Mining Congress, 841 Munsey Building, Washington, D. C.; California Metal and Mineral Producers' Association, San Francisco; Chamber of Commerce and Mines, Douglas, Ariz.; Chamber of Mines and Oil, Los Angeles, Calif.; Nevada Mine Operators' Association, Reno, Nev.; Northwest Mining Association, Spokane, Wash.

Copper—Copper and Brass Research Association, 25 Broadway, New York; Copper Export Association and Copper Institute, 25 Broadway, New York.

Gold—American Gold and Silver Institute, H. N. Lawrie, Managing Director; Rust Building, Washington, D. C.

Graphite—Plumbago-Graphite Association, 17 State St., New York.

Gypsum—Gypsum Institute, 110 West 40th St., New York.

Iron and Steel—American Iron and Steel Institute, 506 Evening Post Building, 75 West St., New York; Association of American Steel Manufacturers, Pittsburgh, Pa.; Lake Superior Iron Ore Association, Cleveland, Ohio.

Lead—Lead Industries Association, F. E. Wormser, secretary; 420 Lexington Ave., New York.

Limestone, Lime—National Agstone Association, Hartman Building, Columbus, Ohio; National Lime Association, 927 Fifteenth St. N.W., Washington, D. C.

Manganese—American Manganese Producers' Association, Metropolitan Bank Building, Washington, D. C.

Petroleum—American Petroleum Institute, 250 Park Ave., New York.

Phosphate Rock—Phosphate Export Association, 420 Lexington Ave., New York.

Portland Cement—Portland Cement Association, 347 Madison Ave., New York.

Refractories—American Refractories Institute, 2202 Oliver Building, Pittsburgh, Pa.

Sand and Gravel—National Sand and Gravel Association, Suite 545 Munsey Building, Washington, D. C.

Slate—National Slate Association, W. S. Hays, Secretary, 644 Drexel Building, Philadelphia, Pa.

Zinc—American Zinc Institute, 27 Cedar St., New York.

Important Mining Securities in 1928*

Company	Exch.	High		Low		Last	Net Change	Sales
COPPER								
Anaconda	N. Y.	120½	De. 31	53⅜	Ja. 18	119⅝	+61⅛	12,704,300
Andes Copper	N. Y.	56	No. 26	36½	No. 5	53¼	.....	2,217,900
Arcadian Con.	B.	2¾	Je.	1	Au.	1⅞	— 1⅛	.....
Arizona Coml.	B.	6	Ja.	3¼	Mh.	4⅜	— 1½	.....
California Cop.	S. F.	9½	No.	2¼	Mh.	8½	.....	.....
Calumet & Ariz.	N. Y.	133	No. 30	89	Fe. 18	123	+ 5¼	1,269,900
Calumet & Hecla	N. Y.	47⅜	No. 8	20⅜	Ja. 10	47	+24⅛	3,432,000
Cerro de Pasco	N. Y.	119	No. 30	61½	Mh. 12	110⅜	+41½	2,726,000
Chile Copper	N. Y.	74⅜	No. 30	37⅜	Mh. 5	73⅝	+31½	3,101,900
Con. Copper Mines	N. C.	16	No.	5	Ja.	13⅞	+ 8½	1,199,100
Copper Range	B.	29⅜	No.	14½	Mh.	27½	+ 7½	.....
Crystal Copper	B. C.	1½	My.	*17	No.	*24	*— 26	.....
East Butte	B.	5	Oc.	1¼	Fe.	3⅞	+ 1⅞	.....
Granby	N. Y.	95	De. 19	39½	Fe. 18	90	+47	1,575,000
Greene Cananea	N. Y.	177	De. 22	89⅜	Je. 19	173½	+21⅝	6,644,700
Howe Sound	N. Y.	73¾	No. 30	40⅝	Fe. 18	68¼	+24¼	1,474,900
Hudson Bay	N. C.	22	No.	16⅛	Je.	20⅜	.....	2,470,600
Inspiration	N. Y.	48⅞	No. 23	18	Fe. 25	47	+26½	1,307,100
Iron Cap	N. C.	8½	My.	2⅜	Se.	3½	+ ⅝	208,100
Isle Royale	B.	28½	No.	11⅛	Fe.	26½	+11½	.....
Kennecott	N. Y.	156	De. 31	80½	Fe. 20	156	+62½	5,542,600
Magma Copper	N. Y.	75	No. 20	43⅜	Fe. 27	70	+14½	1,035,500
Mason Valley	N. C.	2⅛	No.	1	Se.	2	+ ⅛	198,600
Miami Copper	N. Y.	33	De. 31	17⅜	Ja. 5	32⅞	+14½	942,600
Mohawk	B.	65	Ap.	35½	No.	43½	— 6	.....
Mother Lode C.	N. Y.	4½	My. 14	2⅜	Au. 10	3½	+ ⅝	612,200
Nevada Con.	N. Y.	42½	De. 31	17⅜	Ja. 18	42½	+23⅜	5,126,400
New Cornelia	N. C.	47½	No.	25⅜	Fe.	42⅞	+13½	396,800
Noranda	N. C.	70⅜	No.	17⅜	Mh.	63⅜	+39⅛	4,208,400
North Butte	B.	8	No.	*90	Ja.	6½	+ 5⅜	.....
Ohio Copper	N. C.	2	My.	*63	Se.	1⅜	+ ⅛	2,076,000
Old Dominion	B.	20½	No.	9	Mh.	19⅜	+ 7½	.....
Phelps Dodge	N. C.	199½	Oc.	117	Fe.	195	+74½	3,125
Quincy	B.	48⅜	De.	12⅜	Ap.	.....	.....	.....
Rio Tinto	N. C.	235	Ap.	216	Ja.	235	+24	800
Roan Antelope	N. C.	38½	De.	24½	Se.	37⅞	.....	155,400
St. Mary's M.L.	B.	38½	No.	21½	Mh.	36½	+ 6½	.....
Seneca Copper	N. Y.	7½	Oc. 24	2	Ja. 18	5⅜	+ 3⅜	904,700
Shattuck Denn	N. C.	24⅜	My.	6⅞	Ja.	22⅞	+12	11,385,600
Tennessee C & C	N. Y.	19⅞	De. 31	10½	Ja. 16	19	+ 8½	1,084,400
United Verde Ex.	N. C.	25⅜	Ja.	13	Je.	24	— 1½	898,000
Utah Copper	N. Y.	273	De. 29	139	Ja. 17	273	+124¾	2,410
Waite Ackerman	T.	3¾	.....	2½	.....	2¾	.....	.....
Walker Mining	S. L.	2.52½	No. 17	*51	Ja. 4	2.45	+1.95	345,764
Wenden Copper	N. C.	2⅛	No. 17	*68	Se.	1⅞	+ ⅜	506,800
NICKEL-COPPER								
Internat. Nick	N. Y.	269½	De. 19	73⅜	Fe. 24	254½	+168⅝	13,818,400
Int. Nick., pfd	N. Y.	125	Au. 29	108	Au. 30	119	+ 9	14,940
Int. Nick., Can.	N. Y.	46	De. 31	41½	De. 27	46	.....	286,400
Mond Nickel	N. C.	45	De.	31	Oc.	45	.....	36,700
LEAD-ZINC-SILVER								
Ahumada Lead	N. Y.	5¾	Mh. 20	2¾	Ja. 17	3½	.....	1,010,800
Amer. Z. L. & S.	N. Y.	57	Oc. 17	6⅜	Ja. 10	42⅝	+36⅜	2,116,500
A. Z. L. & S., pfd.	N. Y.	117⅞	Oc. 18	40	Ja. 16	105	+64½	421,600
Bingham Mines	S. L.	56	Ja.	41	Oc.	47	— 8⅞	1,040,000
Bunker Hill & S.	N. C.	160	Ja.	108½	Oc.	128	—16	17,500
Butte C. & Zinc	N. Y.	12½	No. 30	4½	Ja. 19	9	+ 4⅝	1,210,500
Butte & Superior	N. Y.	16⅜	My. 21	8⅜	Au. 6	10⅛	— ⅜	503,300
Callahan Z.-L.	N. Y.	5⅜	Ap. 30	1⅜	Mh. 8	3¼	+ 1⅜	681,100
Cardiff M. & M.	S. L.	*91	Ja. 10	*30	No. 10	*37½	*— 49	60,315
Chief Consol.	S. L.	4.725	Fe. 17	3.075	Ja. 3	3.70	*+70	164,172
Con. Le. & Zinc	St.	17⅛	My.	9	No.	12	— 2	.....
Const. M. & M.	S.	*55	De. 1	* 7	Je. 9	*38	*+12	49,690
Eagle-Picher	C.	24⅞	Ja.	15⅜	My.	20½	— 1⅜	.....
Eagle-Picher pfd.	C.	118	Fe.	100	Mh.	110	— 7½	.....
Erupcion	B. C.	*55	Fe.	*18	Au.	*25	*— 25	.....
Eureka Lily	S. L.	2.70	Fe. 17	1.12½	De. 21	1.30	*— 20	601,729
Evans-Wallower	N. C.	17⅞	No.	6⅜	Se.	15½	.....	280,300
Evans-Wal., pfd.	N. C.	85	Oc.	70	No.	80½	.....	41,100
Federal M. & S.	N. Y.	230	De. 5	120	Ap. 17	220½	+70½	21,530
Fed. M. & S., pfd.	N. Y.	102½	Se. 11	91½	Ja. 3	100½	+ 6½	16,400
Gladstone Mtn.	S.	*16½	Ja. 14	* 2	Je. 23	* 4½	*— 6½	434,175
Golconda	S.	1½	Au. 8	*65	Ja. 7	*79	.....	868,605
Hecla Mining	N. C.	18	Ja.	13	Ap.	16⅜	— 1⅜	133,800
Highl'd-Surpr'se	S.	*16⅛	Fe. 4	* 8	Se. 22	*13¼	*— ¼	172,430
Iron King	S. L.	*95	No. 5	*57	Ja. 13	*83	*+26	291,570
Keystone	S. L.	*35	Fe. 28	*25	Ja. 5	*30	*+ 8	23,154
Lucky Jim	S.	*43⅛	Fe. 18	*20	De. 29	*20	*— 8½	223,400
Lucky Tiger-C.	K. C.	8.10	Ja. 10	6.50	Oc. 30	6.50	—1.40	.....
Mammoth Min.	S. L.	2.50	Ja. 6	*70	No. 28	*85	—1.20	14,755
National Lead	N. Y.	136	Ja. 31	115	Jl. 11	130½	+ 1½	160,600
Nat'l Le. pfd. A	N. Y.	147½	My. 18	139	Ja. 3	140	+ 1	13,060
Nat'l Le. pfd. B	N. Y.	122	Jl. 17	112½	Mh. 20	118½	+ 2½	10,230
New Jersey Zinc	N. C.	294	De.	180½	Ja.	292	+107½	57,330
New Quincy	S. L.	*93	Ap.	*20	Fe.	*84	*+58	1,358,975
North Lily	S. L.	8.75	No. 30	3.75	Ja. 7	7.95	+4.20	89,549
Park Bingham	S. L.	*29	Mh.	* 8½	De.	*10	*— 15½	932,569
Park Utah	N. Y.	14½	Ja. 5	9	Au. 15	12	+ 2½	2,552,600
Plutus Mining	S. L.	2.65	Fe. 15	1.40	Au. 22	2	*— 40	5,060
Rico-Argentine	S. L.	*67	Ja. 14	*40	Jy. 13	*47	*— 8	462,060
St. Joseph Lead	N. Y.	71⅛	De. 31	37	Mh. 16	69	+27⅛	685,600
Sherman Lead	S.	*42	Fe. 3	*16	No. 3	*21⅛	*+ 1⅛	169,800
Silver King C.	S. L.	13⅜	Au. 21	10⅜	Mh. 22	12⅝	+ 2⅜	60,150
Silversmith	S.	*30	Ja. 21	* 6½	De. 8	* 8	*— 12	491,908
Strattons (Day.)	S.	1.73	De. 1	*35	Mh. 17	1.60	+1.11	31,700
Sunshine Min'g.	S.	1.64	Ja. 28	1	Mh. 10	1.30	*+10	45,165
Tamarack-Cust.	S.	1.26	Fe. 25	*34	De. 22	*35	*— 35	277,092
Tintic Standard	S. L.	16⅜	Ja. 25	12⅜	Mh. 9	13⅜	+ ⅛	129,583
Tonopah Bel'nt.	N. C.	2⅛	Ja.	*61	Oc.	1⅜	+ ⅛	26,500
Treadwell-Yuk'n	T.	31½	Ja.	8	Je.	10	—15.90	.....
United Zinc	N. C.	1⅜	No.	*25	Ja.	1½	+1.20	26,000
Utah Apex	N. C.	5½	Ja.	3⅜	Au.	3⅝	— 1⅜	59,800
Utah Met. & Tun.	B.	1¼	Ap.	1	Fe.	1⅛	— ⅛	.....
Yellow Pine	L. A.	*30	Jy. 19	*25	Jy. 30	*25	*— 5	.....

Company	Exch.	High		Low		Last	Net Change	Sales
GOLD								
Alaska Juneau	N. Y.	10⅜	De. 4	1	Ja. 5	8½	+ 7½	2,509,200
Barry-Hollinger	T.	1½	Ap.	*27½	De.	*31½	*—86½	.....
Cent. Manitoba	T.	1.93	Ja.	*58	De.	*63	—1.30	.....
Coniaurum	T.	5½	Ja.	1	De.	1½	— 4	.....
Cresson Con	N. C.	2½	Ja.	*58	Oc.	*71	— 1½	177,500
Dome Mines	N. Y.	13½	Ja. 6	8	Je. 13	9½	— 3½	323,100
Golden Cycle	C. S.	1.81	Fe. 24	1.53	De. 4	1.55	*— 0	98,950
Gold Hill	T.	*39½	Ja.	* 5	Oc.	* 7	*—30½	.....
Hollinger Con	T.	18.05	Ja.	7	Oc.	8½	—9.45	.....
Homestake Mng	N. Y.	80	No. 12	69	Ja. 30	75	+ 5	126,900
Kirkland Lake	T.	2⅜	Ja.	1.95	No.	1.65	—1.06	.....
Lake Shore	T.	27.70	Ja.	14⅜	De.	20	—7.15	.....
McIntyre-Pore	N. Y.	28½	Mh. 16	13⅜	Oc. 11	21	+ 9⅜	38,100
Portland Gold	C. S.	*28½	Fe. 21	* 8	De. 13	* 9	*—12	103,675
Rand Mines	N. Y.	45	Ja. 17	35½	Oc. 26	37½	— 1½	2,850
Sylvanite	T.	3.90	Ja.	1.95	Jy.	2.10	—1.70	.....
Teck-Hughes	T.	11.51	Je.	7.50	De.	8.90	—1.75	.....
Tom Reed	L. A.	*62	Au. 13	*35	De. 17	*26	*— 7½	.....
Tough-Oakes B.	T.	*78	Ja.	* 7	No.	* 9	*—67	.....
Unity Gold	N. C.	2	Au.	*35	Ja.	1½	+ 1	140,200
Vipond Con	T.	*99	Mh.	*39	Fe.	*82	*+ 6½	.....
Wright-Harg	T.	6.30	Ja.	1.40	De.	2.22	—4.03	.....
Yukon-Alaska	N. C.	37	Ap.	25	Ja.	31½	+ 7½	13,300
GOLD AND SILVER								
Carnegie Metals	N. C.	27½	Mh.	17	Ja.	19½	+ 2¾	366,700
Cent. Am. Mns.	N. C.	8⅜	No.	*50	.....	7¾	.....	219,700
Coniagas	T.	5½	Ap.	1.70	.....	2	—2.70	.....
Consol. Cortez	N. C.	*32	Je.	*15	No.	*20	*+ 2	119,500
Dolores Esp	N. C.	2	Ap.	*30	Mh.	*39	*+39	218,700
Kerr Lake	N. C.	*65	Ap.	*38	Se.	*50	*+ 4	181,000
Montana-Idaho	S.	*53⅜	Fe. 26	* 9	No. 17	*10⅛	.....	2,257,810
N. Y. & H. Ros.	N. C.	17½	Ap.	12½	Se.	16½	— ⅞	9,800
Premier Gold	N. C.	3½	Ja.	2 1/16	Ju.	2½	.....	213,300
Tonopah Ext	N. C.	*18	Ja.	* 5	Se.	* 6	*— 5	371,500
Tonopah Mng	N. C.	5½	Jy.	2½	Ja.	3½	+ 1⅜	80,400
United Eastern	N. C.	1⅜	My.	*45	Ja.	*85	*+40	192,900
West End Con	N. C.	*7	My.	* 3	Oc.	* 5	.....	38,000
Yukon Gold	N. C.	1¾	No.	*30	Mh.	*90	*+15	116,500
SILVER								
Cas.-Trethewey	T.	*81½	Fe.	*35	Oc.	*38	*— 38	.....
Keeley	T.	*80	My.	*37½	No.	*39	*— 31	.....
Mining Corp	T.	5.50	Ja.	2.92	Oc.	3.95	*— 15	.....
Nipissing	N. C.	5⅞	Ja.	2⅜	Oc.	3½	— 2½	190,500
IRON								
Bethlehem Steel	N. Y.	88⅜	De. 31	51⅞	Je. 19	87½	+29	5,792,140
Bethl. Steel pfd.	N. Y.	125	Ap. 13	116½	Je. 29	124	+ 4	99,000
Cleveland-Cliffs	Cl.	147½	Se.	104	Ja.	130	+25	7,735
Colorado F. & I.	N. Y.	84½	Ja. 23	52½	Je. 25	70½	— 8	2,331,600
Col. F. & I. pfd.	N. Y.	140	Au. 8	127½	Je. 12	130	— 5	30,420
Gt. Nor. Iron	N. Y.	33⅜	Oc. 23	19½	Je. 22	29⅜	+ 6½	1,705,300
Inland Steel	N. Y.	80	De. 11	46	Mh. 3	79	+18½	521,600
Republic I. & S.	N. Y.	94½	No. 20	49½	Je. 19	86	+25½	2,156,700
Rep. I. & S. pfd.	N. Y.	112	Fe. 6	102	Je. 25	109	+ 5	21,403
Sloss-Shef. S. & I.	N. Y.	134	Fe. 6	102	Je. 23	123	— 3	58,900
Sl.-Sh. S. & I. pf.	N. Y.	123	Mh. 24	104½	Oc. 23	106	— 4	4,900
U. S. Steel	N. Y.	172½	No. 16	132⅜	Je. 25	151½	+ 9⅜	19,809,700
U. S. Steel pfd.	N. Y.	147½	Ap. 26	138⅛	Ja. 5	141⅜	+ ⅜	202,900
Virginia I.C. & C.	N. Y.	50	My. 22	25	De. 28	25	—11	2,100
V. I. C. & C. pfd.	N. Y.	62⅜	Ja. 13	47	Oc. 25	48¼	—14¼	2,310
MISCELLANEOUS								
Aluminum Co.	N. C.	197⅜	My.	120	Ja.	151	+31	151,300
Aluminum pfd.	N. C.	110½	No.	104	De.	104	— 1½	52,300
American Metal	N. Y.	53⅜	No. 27	39	Mh. 13	62	— 6½	657,900
Amer. Metal pfd.	N. Y.	117½	My. 14	109	Au. 8	117	+ 6	17,550
Am. Sm. & Ref.	N. Y.	293	De. 31	169	Fe. 27	292	+110	3,249,800
A. S. & R. pfd.	N. Y.	142	Ap. 20	131	Mh. 20	136	+ 4	50,600
A. S. & R. new.	N. Y.	98⅜	De. 29	90	De. 27	97⅛	.....	3,700
Ang. Chil. Nitr.	N. C.	54	Je.	26½	Fe.	33½	+ 4	216,400
Asbestos Corp.	M.	39½	My.	15	De.	17	—18	148,322
Asbestos pfd.	M.	95½	Ja.	59	De.	65	—30	26,868
Consol. M. & S.	M.	399	No.	239½	Au.	379	+113	185,683
DeBeers Consol.	N. Y.	28⅜	My. 9	21	De. 11	21	— 3	58,500
Fed'ated Metals	N. C.	35⅛	De.	14	Mh.	35	+14⅜	53,200
Freeport Texas	N. Y.	109½	Ja. 11	43	Oc. 22	49	—54	3,590,100
Newmont Mng.	N. C.	217⅛	No.	122	Ja.	203	+64⅜	242,700
Patino M. & E.	N. Y.	42	Ap. 30	23⅜	Ja. 3	36⅜	+12⅛	1,980,500
So. Am. G. & P.	N. C.	4⅜	Se.	2⅜	Ja.	3	+ ⅝	5,900
Texas Gulf Sul.	N. Y.	82½	No. 19	62½	Je. 12	79½	+ 6½	6,955,200
U. S. S. R. & M.	N. Y.	71½	No. 27	39½	Fe. 20	65⅝	+21½	543,000
U.S.S.R.&M.pfd.	N. Y.	58	De. 28	52	Ja. 3	57	+ 3	38,800
Vanadium Corp.	N. Y.	111½	No. 12	60	Ja. 18	101⅞	+38½	3,897,600
BONDS								
Al. Gd. cvt. deb. 6's A '25		14	Oc. 31	3½	Ap. 13	8	+ 3½	$78,000
Al. Gd. cvt. deb. 6's B '26		10	Ap. 17	3½	Ap. 13	8½	+ 5½	18,000
A. S. & R. 6's '47		109½	Ap. 12	106⅜	Je. 29	107½	+ ⅛	807,000
A. S. & R. 5's '47		102⅜	Fe. 3	99⅜	Je. 6	101	— 1⅛	3,401,000
Anaconda 7's '38		191	De. 31	110½	Fe. 20	191	+80½	35,543,000
Anaconda 6's '53		106½	Ja. 23	104	Je. 12	105⅛	— ⅛	9,153,000
Andes Cop. 7's '43		241	No. 26	120	Fe. 20	227	+101⅛	83,664,000
Anglo-C. Nitrate 7's '45		105½	Je. 4	92	Oc. 10	94½	— 2	5,257,000
Colo. F. & I. gen. 5's '43		102½	My. 20	97	De. 27	97⅜	— 3½	271,000
Fed'ed Metals cvt. 7's '39		105	De. 21	95	Jy. 21	102½	+ 4	475,000
Inspiration Cop. 6½'s '31		102½	My. 22	100	Au. 14	101⅛	— ⅞	572,000
Nevada Con. 5's '41		99⅜	No.	98½	Ja.	99⅜	+ 1⅛	389,000
Rep. I. & S. rfg. 5½'s '53		105	Ap. 3	101	Se. 25	102⅜	— ⅜	897,000
Rep. I. & S. col. 5's '40		105½	Mh. 28	99⅜	Jy. 14	101⅜	— 1	433,000
Tenn. C. & C. 6's A '41		120	No. 30	101⅛	Ja. 9	112	+11⅛	1,024,000
U. S. S. R. & M. 5's '35		105	Ja.	100	Je.	103	— ⅛	921,000
U. S. Steel s. f. 5's '63		109⅜	Ap. 30	106	Jy. 27	107⅜	— 1⅛	5,466,000
Va. I. C. & C. 5's '49		91¼	Fe. 11	82	Au. 17	81	—10	106,000

* Cents; N. Y., New York Stock Exchange; N. C., New York Curb; B, Boston; S. F., San Francisco; M, Montreal; T, Toronto; S. L., Salt Lake; St, St. Louis; S., Spokane; C., Cincinnati; B. C., Boston Curb; K. C., Kansas City; L. A., Los Angeles; C. S., Colorado Springs; Cl., Cleveland.

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The Market Report

Metal Markets Quietest in Months

New York, Jan. 16, 1929.—The holiday quiet in the metal markets has arrived three weeks late. Scarcely any business at all has been done in copper and zinc, and lead and tin have also been in much less demand than normally. Prices, however, have been generally firm, for the volume of business has been so good in the last month or two that producers are inclined to welcome a breathing spell. There is every indication, also, that consumption is as good as ever, and the business reviews and forecasts are optimistic.

Copper Marks Time at 16¾c.

Some large producers have not sold a ton of copper in the last week, and the total volume of business booked by all sellers has closely approached the minimum for the last year. Continued heavy buying was, of course, not expected, but the lack of interest is even more apparent than it has been at the end of other recent buying waves. What little demand there was came principally from brass mills, and was largely for April shipment, with scattering orders for February and March. Producers have very little copper to offer this side of April, and production for that month has been about half sold. So far, no interest has been taken in May positions. The price is entirely unchanged, at 16¾c. for Connecticut deliveries and the customary differentials for other points. Many expect this price to persist for some weeks to come unless a concerted buying movement should manifest itself.

Consumers report that their plants are as busy as ever, but that an expected slackening of orders was evident in the first half of January. The heavy buying that was done toward the end of last year seems to have been fully justified by consumptive requirements, for there has scarcely been one request to producers to defer shipment.

The December statistics showing an increase in stocks of refined copper amounting to over 13,000 tons have, without doubt, reassured consumers that there would be no difficulty in finding enough copper to go around, and have been influential in tempering the demand during the last week. Domestic shipments fell off 15,000 tons in December, compared with November, but are likely to increase by a similar amount in January, so that stocks of refined should not show another jump of such magnitude.

Foreign copper business has been light this week, at unchanged prices—17c., c.i.f. Hamburg, which level was established on Jan. 3. European consumers are not provided with much of their February copper yet, so a good export market may be expected in the weeks immediately forthcoming.

Little Activity in Lead Market

The lack of strength in the London market that has featured the lead situation in recent months continued in evidence during the greater part of the past week. Yesterday the quotation for spot lead in London declined to £21 15s., which was actually below the current bullion-lead import parity. London was stronger today, however, the price for spot lead advancing to £22, and the danger of a forced reduction in domestic price levels is averted, at least temporarily.

Quiet has prevailed in the domestic market as the result of the weakness in London. The volume of business reported during the week is approximately 40 per cent of normal. Prices are unchanged at 6.65c. per pound in New York, the level of the A. S. & R. Company contract price, and at 6.50c. per pound in the East St. Louis market. Lead has been offered by dealers at price concessions of 0.025 to 0.05c. under the prevailing price in the Middle West, though record of actual transactions at this level is not available.

Daily Prices of Metals

Jan.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
10	16.525	49.25	6.65	6.50	6.35
11	16.525	49.375	6.65	6.50	6.35
12	16.525	49.375	6.65	6.50	6.35
14	16.525	49.125	6.65	6.50	6.35
15	16.525	49.00	6.65	6.50	6.35
16	16.525	49.125	6.65	6.50	6.35
	16.525	49.208	6.650	6.500	6.350

Average prices for calendar week ending Jan. 12, 1929, are: Copper, 16.525; Straits tin, 49.604; N. Y. lead, 6.650; St. Louis lead, 6.500; zinc, 6.350; and silver, 57.354.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
10	75¼	73 9/16	78¼	223¼	223¼	22⅛	22⅛	26⅜	26 9/16
11	75⅛	73⅜	78¼	224	223⅞	22 1/16	22 7/16	26 5/16	26½
14	75	73	78¼	222½	222½	21 15/16	22 5/16	26½	26⅜
15	74⅝	72 13/16	78¼	222¼	222⅛	21⅞	22	25¾	26
16	74⅝	72⅞	78¼	223	222⅛	22	22 3/16	26	26 1/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
10	4.84⅜	57½	26 7/16	84s11½d	14	4.84⅜	57½	26 7/16	84s11½d
11	4.84 11/16	57¼	26⅜	84s11½d	15	4.84⅜	57½	26 5/16	84s11½d
12	4.84⅜	57½	26 7/16	.....	16	4.84½	57⅜	26¼	84s11½d
					Ave.		57.354		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

The general feeling in the trade remains confident as to the future price trend, though optimism is more tempered than it has been. Much of the past week's business has been in carload lots to small consumers. Prompt and February shipment was specified on most sales, though one of the week's few large orders was for March delivery.

Zinc Dull But Price Firm

As in the copper market, buyers of zinc have stayed away in droves during the last week. Selling has been well distributed, but each agency reports only an occasional carload sold, so that the total volume is the smallest in months. Though reports of prices as low as 6.30c., St. Louis, have been published in daily papers, there seems no justification for any quotations below 6.35c., which producers are uniformly getting. The lower price may obtain on an occasional small lot sold by a dealer insistent upon selling in the present dull market.

December statistics released by the American Zinc Institute, in tons of 2,000 lb., follow:

Stock, Dec. 1	46,542
Produced	50,591
Shipped	51,692
Stock, Dec. 31	45,441
Shipped from plants for export	2,067
Metal sold but not delivered, Dec. 31	45,378
Total retort capacity, Dec. 31.	116,136
Number idle retorts available within 60 days	50,300
Average number retorts operating in December	64,320
Number retorts operating Dec. 31	61,544

Tin Market Featureless

The controlled nature of the tin market becomes more evident as time passes, and the excess of production over consumption is maintained, with prices continuing highly stabilized. Prices have fluctuated within a relatively narrow range during the last week, and trading has been very light.

Foreign Exchange

Closing cable quotations on Tuesday, Jan. 15, were as follows: Francs, 3.90$\frac{11}{16}$; lire, 5.23$\frac{5}{16}$; and marks, 23.77$\frac{1}{2}$. Canadian dollars $\frac{1}{4}$ of 1 per cent discount.

Silver Eases Off

During the first half of last week the silver market was steady to firm, with good buyers for China account, but as support was temporarily withdrawn from that quarter prices eased off, and the market closes today with an easier undertone. India has shown little interest at these levels.

Mexican Dollars (Old Mexican pesos): Jan. 10th, 43$\frac{3}{8}$c.; 11th, 43$\frac{1}{8}$c.; 12th and 14th, 43$\frac{3}{8}$c.; 15th, 43$\frac{1}{8}$c.; 16th, 43c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 9$\frac{3}{8}$@9$\frac{1}{2}$c. per lb. for all positions. Cookson's "C" grade, spot, 14$\frac{3}{4}$c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM — Per lb., New York: 80@95c. Active demand.

IRIDIUM—Per oz., $270@$275 for 98 @99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $42@$44. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $70. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

QUICKSILVER — Per 76-lb. flask. $119@$120, cash. Small lots command the usual premiums. Market quiet.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Jan. 5.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: wolframite, $12; Western scheelite, $12.50@$13.

Chrome, Iron, Manganese, Tantalum, Titanium, and Vanadium ores are unchanged from quotations in the Jan. 5 issue.

Galena Higher in Joplin

Joplin, Mo., Jan. 12, 1929

Blende	Per Ton
High	$41.85
Premium blende, basis 60 per cent zinc	$40.00@ 41.00
Prime Western, basis 60 per cent zinc	39.00@ 40.00
Fines and slimes, 60 per cent zinc	36.00@ 38.00
Average settling price, all zinc	38.90
Galena	
High	$88.60
Basis 80 per cent lead	87.50
Average settling price, all lead	86.88

Shipments for the week: Blende, 10,209; lead, 1,546 tons. Value, all ores the week, $531,430.

No effort at further restriction of the output is evident. Rather it seems assumed that as stocks have been reduced to a low point by previous efforts at restriction there is no immediate need of holding down the output.

The price of lead concentrate was advanced $2.50 per ton today, with all offerings on a basis of $87.50 per ton of 80 per cent lead.

Platteville, Wis., Jan. 12, 1929

Zinc Blende	Per Ton
Blende, basis 60 per cent	$42.50
Lead Ore	
Lead, basis 80 per cent	$87.00

Shipments for the week: Blende, 619 tons; lead, none. Shipments for the year: Blende, 1,484 tons; lead, 40 tons. Shipments for the week to separating plants, 571 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Jan. 5 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Market firm.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Jan. 5 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $33@$34 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.04@$1.10.

NICKEL SILVER — Price for 18 per cent Grade A sheets, 31$\frac{1}{2}$c. per lb.

YELLOW (MUNTZ) METAL—Price for dimension sheets, 22$\frac{1}{4}$c. per lb.; for rods, 19$\frac{1}{4}$c. per lb.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Jan. 5 issue.

Rolled Metals

COPPER—Price for sheets, hot rolled, 25$\frac{7}{8}$c. per lb.; for wire, 18$\frac{5}{8}$c. per lb.

LEAD SHEETS — Effective Jan. 7. Price for full-rolled sheets advanced from 10$\frac{1}{4}$ to 10$\frac{1}{2}$c. per lb.; and for clipped sheets from 10$\frac{1}{2}$ to 10$\frac{3}{4}$c. per lb.

Monel Metal, Nickel, and Zinc Sheets are unchanged from prices in the Jan. 5 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Jan. 5.

Iron, Steel and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $18.25; basic, $17.50@$18; No. 2 foundry, $18.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per lb., 1.90@2c.

Coke—Per gross ton, Connellsville furnace, $2.75. Connellsville foundry, $3.75@$4.85. Byproduct coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.